INCLUSION Project

Deliverable 1.2

Review and classification of prioritised area types and user groups and identification of challenges and gaps

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Abstract	In D1.2, *Review and classification of prioritised area types and user groups and identification of challenges and gaps*, we provide a comprehensive overview of social, economic, and geographic considerations that may contribute to characterisations of 'vulnerable' users and areas. Challenges and opportunities associated with providing adequate and efficient transport services for these populations and areas are described with reference to area types; user segments; mobility options; transport infrastructure and service provision; key societal trends affecting mobility and accessibility, inclusivity and equity, and the impacts (potential or experienced) of such trends on vulnerable users. A number of key characteristics are identified for further exploration and carry through throughout the report, particularly in relation to current gaps in transport provision as they relate to the needs and challenges of vulnerable users and areas. We align these findings with potential ways for addressing or mitigating these gaps including looking to new models of transport service provision, and additional incorporation of technological solutions. From this, we draw together findings from the literature and examples of good practice to create a reference document for future work in the INCLUSION project and beyond.

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1 Executive Summary

As set forth in the project proposal, the INCLUSION (Towards more accessIble and iNCLUSIve mObility solutions for EuropeaN prioritised areas) project aims to *"…understand, assess and evaluate the accessibility and inclusiveness of transport solutions in European prioritised areas, to identify gaps and unmet needs, propose and experiment with a range of innovative and transferable solutions, including ICT-enabled elements, ensuring accessible, inclusive and equitable conditions for all and especially vulnerable user categories."* As part of this remit, D1.2 (Review and classification of prioritised area types and user groups and identification of challenges and gaps) aims, firstly, to identify social, economic, and geographic considerations that may contribute to characterisations of 'vulnerable' users and areas. Challenges and opportunities associated with providing adequate and efficient transport services for these populations and areas are then described with reference to: area types; user segments; mobility options; transport infrastructure and service provision; key societal trends affecting mobility and accessibility, inclusivity and equity, and the impacts (potential or experienced) of such trends on vulnerable users.

In Section 2 we provide a discussion of the primary area and user characteristics considered across the report, with the following having been identified as particularly relevant given their potential impacts on the transport experience and the need to plan for more socially just and inclusive networks of mobility:

- Geographic or area considerations:
    - Primary Geographic Area and Destination Geographic Area (particularly considering degrees of urbanity and rurality)
    - Topography
    - Climate
    - Economic vitality
    - Population and Economic trends
- Demographic considerations:
    - Age
    - Sex
    - Disability
    - Migrant status
    - Student status
- Economic considerations:
    - Income
    - Employment
- Behavioural segmentation
- Societal trends:

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- Distribution of wealth and labour market development
- Urbanisation
- Environmental protection
- Changing governance models
- Ageing societies
- Increased migration to urban areas

While efforts have been made to address relevant characteristics in a comprehensive manner, this report does not claim to have addressed all potential considerations that may be germane to areas and populations prioritised by the INCLUSION pilot labs, nor to more general considerations of other European cities and sites. Rather, we have identified and discussed some of the key characteristics that may, singularly or in combination with other factors, present challenges to the provision of equitable transport services. We have also attempted to address characteristics that may introduce challenges that would apply across a wide spectrum of users (for example, lack of access to reliable mobile data coverage through which transport information may be obtained would present a challenge for both low-income and remote rural populations).

Based on the characteristics identified, a candidate list of 15 area types were highlighted for further exploration in WP3. These area types were developed based upon the literature reviewed and with consideration of concerns expressed by the pilot sites; however, they are presented as candidate sites only and are subject to amendment and/or replacement as the project progresses. Of note is that they are designed to represent a mix of area and population types; in addition to representing the multidimensional influences of characteristics on mobility access, equity, and provision. It is anticipated that these will be further refined and/or changed as the project moves forward.

Reflection on the identified users and characteristics then provides the groundwork for further exploration of the current state of the art and emerging trends in mobility offers, along with the influence of technology in providing mobility services. Overall, Section 2 provides the context for further identification of the challenges and needs faced by different user segments and area types presented in Section 3. Here, we address current gaps in transport provision as they relate to the needs and challenges of vulnerable users and areas identified in Section 2, along with potential options for addressing these gaps. This is followed by positioning the Pilot Labs in the framework of the prioritised areas and target user groups.

In the conclusion, we aim to draw together the findings from the reviewed literature and examples of good practice in the context of key considerations and challenges, as well as suitability of methods for addressing these, for sites representing some or all of the candidate characteristics. It is hoped that this will add to the development of future work throughout the project development and beyond.

2 Introduction (UNIABDN (R))

2.1 WP1 in the context of the INCLUSION project

"The main objective of the INCLUSION project is to understand, assess and evaluate the accessibility and inclusiveness of transport solutions in European prioritised areas, to identify gaps and unmet needs, propose and experiment with a range of innovative and transferable solutions, including ICT-enabled elements, ensuring accessible, inclusive and equitable conditions for all and especially vulnerable user categories (proposal, p. 3)." To respond to this overall objective, a systematic literature review has been undertaken in order to identify characteristics of both prioritised areas and their populations, as well as ways in which transport solutions have been implemented in order to respond to the specific needs identified.

WP1 – Prioritised areas, user groups and needs assessment – will lay the foundations of the project by examining accessibility and inclusiveness issues in the dual perspective of the different types of prioritised areas and the various population groups and user segments. WP1 will investigate the main characteristics of prioritised areas as regards spatial demographic and socio-economic aspects, and will identify and analyse the main user groups and related transport accessibility issues, with a particular focus on vulnerable user categories. Furthermore, it will investigate the mobility habits, needs and aspirations of various vulnerable social groups in specified spatial categories, and how the respective mobility influencing factors, limitations and barriers can result in a lack of equity and inclusiveness and other undesirable effects. This WP will result in a structured view linking the various characteristics of prioritised areas and user segments with the main issues and factors that affect mobility and inclusiveness, as well as in the identification and understanding of a comprehensive and organised set of needs and requirements that must be met by novel transport solutions in order to ensure adequate levels of accessibility for all citizens and residents in the reference areas.

2.2 WP1 objectives and tasks

WP1 sets the contextual background to the project by a thorough investigation of the characteristic of prioritised areas, their target user segments and their needs. This is achieved by investigating an initial broad range of experiences and initiatives across Europe, which will be selected and analysed from the perspective of transport accessibility, inclusivity and equity. These will include a number of relevant experiences identified prior to the start of

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the project and others resulting from a review of the existing literature on mobility and transport accessibility. The review will be augmented by analysis of results from previous studies produced by sectoral transnational organisations such as EMTA, UITP, EPF, POLIS and others. The main findings of recent and on-going Horizon2020 projects in which consortium partners are engaged or are associated with (e.g. CIPTEC, MIND-SETS, SocialCar, CHUMS, etc.) will also be analysed.

WP1 has the following objectives as set forth in the project proposal:

- To conduct a thorough investigation of the characteristics of European 'prioritised areas' for public transport (PT) in terms of spatial, demographic, and socio-economic characteristics;
- To classify the various area types in relation to the general and local mobility environment, transport network and services offered to the user groups who live, work and travel in the area;
- To investigate the mutual effects between the different social, demographic, ethnographic and behaviour features and how they combine to create the conditions of vulnerability for mobility;
- To categorise the targeted vulnerable user groups, identify the main challenges and elements that affect mobility and transport provision for specific areas, and accessibility and inclusivity for different user segments;
- To develop a detailed understanding of the different mobility needs and transport requirements of each user group, and establish the cross-relations between each user group and the territorial contexts of most relevance for this group.

WP1 is divided into three Tasks, which are outlined below.

- ***Task 1.1: Identification and classification of specific areas and targeted user groups.***

This task will seek to identify and categorise the existing mobility experiences of targeted user groups from a range of prioritised areas across Europe.

- ***Task 1.2: Identification of challenges and comprehensive user needs analysis.***

Changing societal trends and rapidly evolving mobility needs of various population groups have increased the difficulties experienced by the public transport sector in developing suitable customer-centred services and establishing a comprehensive understanding of the users and their service needs. With the exception of reduced mobility groups and the elderly, efforts to understand the emerging needs of other disadvantaged user groups have often been lacking, under-researched, or have led to quickly obsolescent views.

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This task will seek to identify the challenges and elements affecting transport accessibility, inclusivity and equity in terms of mobility for targeted user groups, in specific prioritised areas as identified in Task 1.1, and will perform a comprehensive and detailed analysis of mobility needs and requirements of such groups.

- ***Task 1.3: Outcomes assessment and validation.***

The findings from previous tasks will be assessed and consolidated in the final phase of WP1 activities by means of validation exercises conducted within a group of selected mobility stakeholders and users' representatives. Task 1.3 will perform a critical assessment of the main outcomes of the previous phases of the investigation conducted and produce the final results of the WP.

2.3 WP1 in relation to WP2, WP3 and WP4

The main result of WP1 will be the definition of a set of prioritised areas, identification of gaps in knowledge relating to the role of social innovation and inclusive mobility in such prioritised areas and provision of criteria for the identification and selection of a sub-set of case studies (around ten) that will be subject to in-depth investigation later in the project (WP3).

WP2 will undertake an analysis and review of existing experiences of ICT-enabled social innovation by focusing on technological aspects and utilisation of ICT solutions in the social context identified in WP1.

In WP4, the assignment of the ideas/solutions to the Pilot sites will be carried out in order to cover the main thematic areas identified in WP2 and a wide range of prioritised areas and categories of vulnerable users identified in WP1.

2.4 Methodology for development of the review (literature review, etc.)

WP1 analysis will combine the investigation of selected experiences and initiatives identified through the review of literature and documents obtained from relevant stakeholders with empirical research with users and stakeholders.

The method undertaken for Task 1.1 comprised a systematic search of academic literature by inputting relevant key terms (such as: 'transport mobility'; 'transport equity'; 'transport accessibility'; 'transport inclusivity' etc.) into academic literature search engines (for example: ScienceDirect; Scopus; Google Scholar) as well as specific academic journal websites (for

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instance: Case Studies on Transport Policy; Journal of Public Transportation). Further searches took place for relevant grey literature, such as publicly-available policy and other documentation, using online searches on specific transport and other related websites. The literature findings were recorded in a set of matrices that were uploaded to Google Drive. This enabled the matrices to be viewed by all WP1 partners, and for UNIABDN, MEMEX, and RUPPRECHT to populate the matrices with details from additional literature and other documentation, as well as having additional input from EMTA and POLIS in the review of this Deliverable. Matrix 1 contained information from research on prioritised areas and user groups, while Matrix 2 focused on studies on societal trends and mobility effects.

In each Task, the following activities will be performed.

Task 1.1:

- Definition of the conceptual and terminological background of the project as regards the main themes addressed (prioritised area, inclusion, equity, equality, social innovation, shared economy/services, accessible transport, mobility impairment, paratransit, etc.), ensuring internal mutual understanding and helping to streamline the external communication (WP7).
- Classification and categorisation of different transport environments (area types) including: urban; peripheral-urban; sub-urban; semi-rural; rural and remote; economically deprived; and areas characterised by declining or ageing population, in relation to the general and local mobility environment, transport network and services.
- A review of different mobility options and transport provision, including: public, private, fixed route and flexible transport options; active travel; and virtual mobility, across area types; and the extent to which new technologies are influencing their operation.
- Classification and categorisation of the target user groups in each area type, in terms of the demographic and socio-economic characteristics of users (for example: households, elderly, children, youth, disabled, migrants, etc.) as well as of complementary behavioural analysis and segmentations.
- Identification of the effects of societal trends (urbanisation and urban sprawl, income distribution, household composition, emerging lifestyles, use of new technologies, ageing, immigration, etc.) on transport and mobility and how these determine or affect vulnerable user groups.

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Task 1.2:

- Identification of gaps in transport infrastructure and services provision that creates challenges in terms of mobility and accessibility for different user groups.
- Identification of major user needs and unsatisfied mobility requirements for each relevant user segment.
- Identification of challenges and elements affecting equity and inclusivity in mobility and transport services among different user segments.

Task 1.3:

- The main outcomes and conclusions to be validated will be organised in structured questionnaires (on-line surveys) circulated within a targeted set of stakeholders reached via the project partners – particularly user groups, operators/service providers and networking partners such as POLIS and EMTA – and the external experts and network organisations involved in the project Stakeholders' Forum – e.g. EUROCITIES, ICLEI and the AGE Platform Europe, the European Network of Migrant Women etc. The surveys will be designed to elicit opinions on accessibility, inclusivity, and equity, in terms of mobility, transport infrastructure and service provision, and highlight any mobility challenges faced, gaps in provision, drivers and barriers.
- A dedicated workshop will be held involving the INCLUSION Stakeholders Forum to allow an open discussion and co-participative evaluation of WP1 outcomes. The event will involve a balanced mix of experts (transport and mobility professionals, social scientists, etc.) and stakeholders (Agencies, Operators, Local Authorities etc.) and will help validate and consolidate the main conclusions in an EU-wide perspective, as well as strengthening the EU level consistency and relevance of WP1 results. Emphasis will be placed on determining the accurate classification of different transport environments (area types) in relation to the provision of transport infrastructure and services. It will also assist with the categorisation of targeted (particularly of vulnerable) user groups by the identification of demographic and socio-economic characteristics of the various user segments; and will offer insight into the presence and usage of various mobility and transport options.

2.5 Aims of deliverable D 1.2

The aim of D1.2 is the 'Review and classification of prioritised area types and user groups and identification of challenges and gaps'.

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2.6 Definitions

For definitions of key terms used throughout the document, please refer to INCLUSION D1.1 'Definition of Terms'.

3 Part A – Review and classification of prioritized area types and user groups (UNIABDN, RUPPRECHT, SOFT, MEM, EMTA, POLIS)

3.1 Classification of different transport environments (area types) and problems (UNIABDN (R), RUPPRECHT (C))

In this section, we present the results of the rapid review with respect to the classification of different prioritised areas in relation to the general and local mobility environment, transport network and services and some of the problems identified, in order to set the stage for further discussion of how such issues may be addressed within the bounds of the INCLUSION project, as well as providing criteria for the identification and selection of a sub-set of case studies to be subject to in-depth investigation later in the project (WP3).

Within the INCLUSION project, 'prioritised areas' are understood to encompass spatial, demographic, and socio-economic characteristics that may impact negatively upon mobility equality. The literature review undertaken to clarify and elaborate upon these broad categories was based upon criteria that both considered a range of site characteristics that may impact upon mobility and acknowledged characteristics of the INCLUSION Pilot Sites. Case studies from across Europe, as well as worldwide, were considered in order to expand upon the features of interest considered to allow for inclusion of area traits that may develop over the course of the project and beyond. The full set of literature considered is presented in Appendix X ('Matrix 1: Review of Prioritised Areas'), while below we define and summarise the prioritised areas, and present potential mobility challenges with which they are associated. Tables 2.1a and 2.1b below also provide a summary of the characteristics considered, as well as their relationships o the Pilot Sites.

3.1.1 Definition of prioritized areas

In order to define 'prioritised areas' as considered within INCLUSION, it was first necessary to disaggregate the various constructs contained in the conception of 'area'. To differentiate the objective of this task from that of considerations around the target user groups

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(addressed in detail in section 2.4 'Classification of the target user groups in each area type'), at this stage, 'prioritised areas' were considered to reflect the geographic, economic, and topographic characteristics of areas, rather than the more specific characteristics of the persons being served. To avoid creating too narrow a focus, case studies both within and beyond Europe were explored. The outcome of the literature review, combined with the professional expertise of the consortium, was used to create definitions that encompassed a wide range of areas that have been considered in the literature and that present varied mobility challenges both individually and in aggregate. From the literature review, the following were defined as potential characteristics of areas that may require consideration as INCLUSION moves forward, though it should be noted that many of the concepts presented are defined operationally within the literature, particularly depending upon the geographic context:

- Primary Geographic Area (i.e. the spatial area in which the population of interest is resident) and Destination Geographic Area (i.e. the spatial area to which the resident population desires or requires access); for example (based upon the OECD Regional Typology):
    - Predominantly Urban (PU), if the share of population living in rural local units is below 15%;
    - Intermediate (IN), if the share of population living in rural local units is between 15% and 50%;
    - Predominantly Rural (PR), if the share of population living in rural local units is higher than 50%.
    - These may be further disaggregated to indicate proximity to nearest town, as indicated in Figure 2.1a below.

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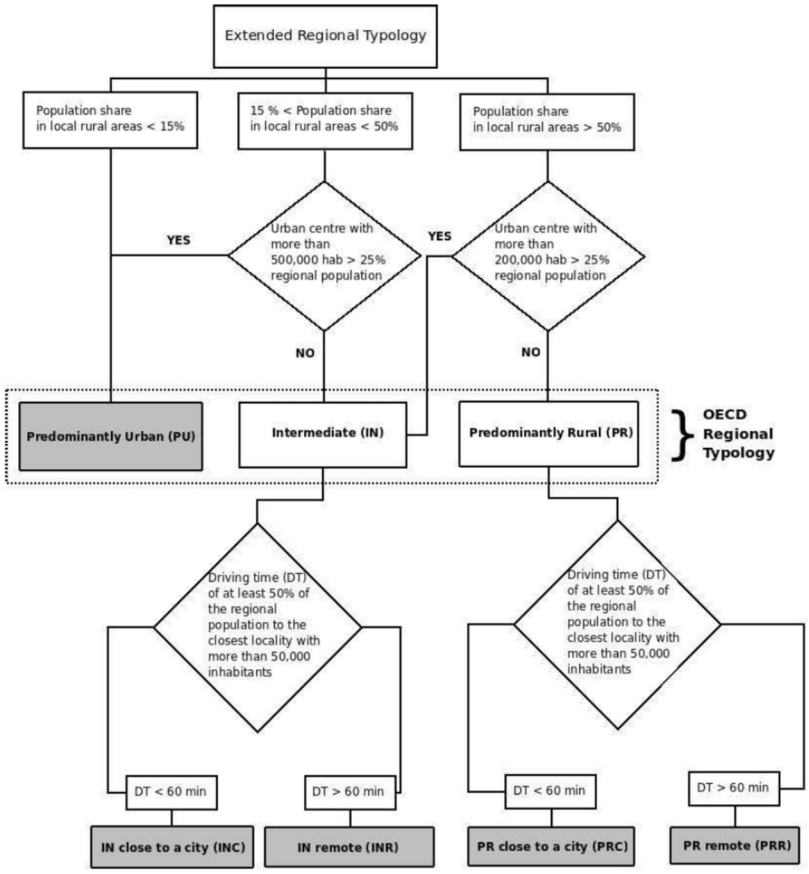

Figure 3.1: OECD Typology for Regional Geography (Source: Brezzi et al., 2011)

- Topography (i.e. the physical geographic characteristic of the area of interest):
  - Hilly: Irregular, steep, or otherwise challenging topographies.
  - Flat: Areas with few or no transport impedances caused by topographic factors.
  - Island: Areas with limited or no roadway connectivity to proximate areas based on geographic isolation.
- Climate (based on the Köppen climate classification system):
  - Tropical: Wet, Monsoon, Wet and Dry
  - Dry: Arid, Semiarid
  - Mild: Mediterranean, Humid subtropical, Marine
  - Continental: Warm summer, Cool summer, Subarctic
  - Polar: Tundra, Ice cap
- Economic vitality (i.e. the relative affluence of the prioritised area):
  - Deprived area: Areas with a high concentration of households suffering from material deprivation, defined as: "…the inability for individuals or households to afford those consumption goods and activities that are typical in a society

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at a given point in time, irrespective of people's preferences with respect to these items" (OECD, 2007).
    - Affluent area: Area characterised by low or no concentration of households suffering from material deprivation.
    - Mixed area: Areas with a mix of affluent and deprived households.
- Population and Economic trends (i.e. the relative population and economic trajectories of the prioritised area):
    - Growing: Generally indicated as areas experiencing growth in Gross Domestic Product (GDP), but also seeing increase in indicators such as employment opportunities, population or labour productivity.
    - Declining: Areas seeing declines in GDP, reductions in employment opportunities, outflow of population, or other factors indicating relative economic decline or instability.
    - Stable: Areas experiencing only minor fluctuations in their economic stability and population numbers, with continued opportunities for employment, education and training within the area.

These characteristics, and their interactions, will impact upon the transport environment being considered and its relationship to social inclusion/exclusion, as well as the potential interventions that may be implemented to mitigate concerns related to these characteristics. Some of the impacts of these characteristics with respect to the transport environment are discussed in Section 2.1.2 below. 'Prioritised areas' will thus be those that have individual or composite characteristics that may contribute to limiting mobility and/or accessibility options.

3.1.2 Identification of prioritized areas in different transport environments

While a number of relevant area characteristics have been identified above, how they contribute and / or influence the transport environment (i.e. the way in which transport services are organised and delivered), and their potential contributions towards the determination of 'prioritised areas', requires further elaboration. In this section, we outline how the different factors may contribute to the development of area transport networks, followed by a more targeted discussion of the various challenges that each raises in section 2.1.3.

Primary and Destination Geographic Areas

The residential and employment populations and relative densities of geographic areas have been noted as some of the primary influencing characteristics on mobility needs, services, and challenges (Chen et al., 2008; Schwanen et al., 2004; Stead and Marshall, 2001). While at times considered as a binary distinction of urban and rural, the use of the more nuanced OECD regional typology (complemented by their further disaggregation based on accessibility) provides clearer scope for distinguishing between the varying transport

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environments experienced, based not only on relative population densities, but also on characteristics of access to goods and services (Gray et al., 2008). Impacts of these characteristics on transport environments may include considerations such as:

- suitability of fixed-route versus demand-responsive or flexible public transport services, where, for example, Wang et al. (2015) found that Demand-Responsive Transport (DRT) is used more frequently by those who are disabled, travelling for work, or who live in less densely-populated areas (Mageean and Nelson, 2003; Wang et al., 2015);
- distance of travel or ease of accessibility to necessary goods and services through active means (such as walking or cycling), for instance, Saelens et al. (2003) found that residents living in communities with higher density, greater connectivity, and more land-use mix had higher rates of walking/cycling than did residents from low density, poorly connected, and single land-use neighbourhoods (Saelens et al., 2003; Van Cauwenberg et al., 2012)
- patterns of mobility and access of area residents and visitors (e.g. tourists, business travellers, etc.) (Goncalves et al., 2017; Caulfield, 2015).

It is important also to consider both the characteristics of the population areas served, as well as the destinations to which they are travelling, in order to ensure that the transport service(s) implemented are responsive to the needs and requirements of all journey segments. Prioritised areas included in the INCLUSION pilot lab sites range from large urban areas (such as Florence, Barcelona and Budapest) to very remote rural areas (Cairngorms National Park).

The distinction between the primary and destination geographic area relates to the geographic area where the population to be served resides, versus the area of primary destination 'pull' – for example, areas of service provision, leisure activities, or employment. Both are considered here, as they may have distinctly different characteristics according to the classification.

Topography

The topography of service areas will impact upon the suitability of different types of transport, both with respect to the implications for roadway geometry, as well as to the comfort and ability of travellers. The need to consider this is highlighted in a study by Daniels and Mulley (2012), which notes the importance of taking into account the topography of an area when planning and developing public transport provision. For example, where there is steep or hilly terrain with narrow lanes or tight curves, large capacity vehicles may be unable to cope with the required turning radii or roadway slopes (Ceder et al., 2015), necessitating smaller vehicles with lower capacity. Steep or uneven terrain may also impact upon the suitability of walking or cycling as a mode choice (Guo and Ferreira, 2008), with Vandenbulcke et al. (2011) finding that much of the inter-municipality variation in bicycle

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use in Belgium is related to environmental aspects such as the relief (topography) as well as to traffic volumes and cycling accidents. Again, the INCLUSION pilot lab sites range from quite flat, to moderately hilly, to mountainous.

Climate

Climate, and associated weather, will impact both upon the types of transport interventions planned in an area, as well as the habits of users within those areas. While we often address the impacts of extreme or adverse weather on travel decisions (for example, Khattak and De Palma (1997) in a study of Brussels commuters found that more than one-quarter reported that adverse weather was either very important or important in changing their mode), it may be equally important to address the overall climate of an area when considering transport interventions. In a systematic review of the literature, for example, Böcker *et al.* (2013), concluded that, "Individual weather parameters have profound impacts on travel behaviour. Warm and dry weather conditions influence outdoor leisure activities and the use of active transport modes positively. Rain, snow, windy, cold and hot weather (above 25–30 8C) often result in a switch from open-air to sheltered transport modes and decrease the number of visits to outdoor destinations. Departure times, travel times and routes are also influenced by these weather parameters." In addition to these considerations, areas that experience extreme variations in temperatures (such as very hot, wet summers and extremely cold winters with snow or ice) may also need to consider them when planning and implementing transport services, due to infrastructure and/or maintenance requirements.

Economic Vitality

The economic characteristics of an area will impact both upon the amount of investment that may be made into the local transport system, as well as on the travel behaviour patterns of its residents and visitors. It is important to note that definitions of deprivation may vary among the European states, notwithstanding common indicators proposed by bodies such as OECD, and these will need to be considered when describing the economic status of an area. Extensive transport investment may require access to immediate funds, as well as ongoing financial security to ensure maintenance and upkeep of facilities, services, and physical and digital infrastructure in order to fully capitalise on the initial investment; considerations that should be taken into account during the decision-making process, as recognised by Mardani et al. (2016), who note that "sound socio-economic and environmental efficiencies are necessary for promoting effectual practices in transportation management" (p21). In addition, the economic characteristics of the population area served must be taken into consideration when allocating transport resources, to allow for recognition of factors such as: access to a private vehicle, working hours or other travel patterns, availability of funds for public transport fares, familiarity with the local transport network, and other characteristics that may reflect the overall economic status of the prioritised area (Di Ciommo and Lucas, 2014; Golub and Martens, 2014). A study by Lucas et al. (2008) focused on transport schemes in deprived areas and found service users to be

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in support of transport provision that addressed their specific needs. In INCLUSION, a number of pilot sites (including Florence and the Cairngorms National Park) are focused on low income populations, thus requiring consideration of economic deprivation, generally, when exploring transport interventions.

Population and Economic Trends

Consideration of the relative growth or decline in an area's population and economy may impact upon transport decisions made by areas as they look to address both immediate and more long-term needs. Alternately, transport infrastructure investment may stimulate economic development (and, in turn, population increase), providing certain other policy, investment, and economic factors are present (Banister and Berechman, 2001). While addressing the needs of the current citizenry is critical in designing effective transport networks, patterns of investment may impact upon future options, which should take into account the emerging mobility patterns evidenced by shifting or transitioning economies (for example, from an industry to service-based economy), patterns of migration, and relative wage rates. Population increases or decreases should also be taken into consideration, as these may impact, for example, upon transport coverage in an area (such as when new developments are constructed outside of traditionally-served areas to house new residents) or timing and accessibility needs when areas are declining. Such trends, which encompass many of the considerations noted above, should be used to establish the emerging transport priorities of areas.

Conclusion

A variety of factors have been highlighted here as affecting the transport environment (namely, primary and destination geographic areas, topography, economic vitality, and economic trend) and the definition of characteristics of prioritised areas has worked to incorporate elements from all of these factors.

3.1.3 Understanding of mobility challenges related to different area types and prioritized areas

As indicated in section 2.1.2, various physical and economic characteristics of a location introduce a wide array of transport considerations, which may translate into mobility challenges to be addressed by the considered prioritised areas. Such challenges may include the following:

Primary and Destination Geographic Areas

As mentioned earlier, it is important to consider both the characteristics of the population areas served (primary geographic areas), as well as the destinations to which they are travelling (destination geographic areas), in order to ensure that the transport services(s)

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implemented are responsive to the needs and requirements of all journey segments. As widely covered in the literature, the mobility challenges facing rural and urban areas (and their various permutations as described above) may differ significantly based on factors such as the density of populations served, employment and leisure opportunities offered, and the financial considerations brought about by these characteristics. The INCLUSION pilot sites provide good representations of these considerations, as they vary in their population sizes and the relative attractions of the destination areas served. Some of the key challenges to be addressed that relate to the relative size and density of the areas under consideration include the following:

- Low population densities may make the provision of fixed-route public transport services financially untenable, as the cost of providing services may not be offset by farebox revenue. This, in turn, may lead to services that are, "…characterized by low frequencies, limited hours of operation, indirect routes and inconsistent connections between modes (Petersen, 2016)."
- Urban areas, on the other hand, may have challenges related to the provision of adequate services for a densely populated and heterogeneous area. Urban areas, for example, may have high concentrations of mobility-limited users, which may strain resources for provision of adequate services.
- Geographic differences in origin and destination areas may also present mobility challenges, for example, when persons in more sparsely populated rural or suburban areas require travel to or from a more centralized urban area for work, services, or recreation at off-peak hours.

These and other challenges have already been identified as areas of consideration and potential investment by various pilot sites.

Topography

As noted above, considerations of topography may present mobility challenges due to physical constraints related to features such as slope of land or limitations to connectivity. It should be noted, however, that mobility challenges may also be presented by predominantly flat land; for example, safety considerations may be heightened in areas where there are long straight roadways, as drivers may not adequately follow speed restrictions (Stamatiadis et al., 2010). Challenges for active transport users are also highly related to topographic considerations, as walking and cycling may be discouraged in areas of steep slopes or uneven terrain, while aforementioned safety considerations may have a disproportionate impact upon active travel users depending on the popularity of an area for these activities.

Climate

Climate considerations may present challenges in terms of effectively serving populations in areas that limit the comfort or accessibility of certain modes – for example, walking or

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cycling may be less appropriate in areas that experience extremely cold or hot temperatures, or that have sustained periods of heavy precipitation. In addition, weather cycles (again, noting extreme changes between summer and winter) may make maintenance and upkeep of certain transport infrastructure challenging, or require different approaches to transport provision over the course of a year.

Economic

Mobility challenges related to economic considerations are common issues faced by municipalities and regions, as mobility needs and constraints may differ according to the overall economic status of an area. For example, in a French study conducted by Pappalardo et al. (2015), they found that, "…human mobility, and mobility diversity in particular, is associated with socio-economic indicators on a municipality scale. To be specific, on a municipality level mobility entropy is positively correlated with per capita income and negatively correlated with deprivation index, primary education rate and unemployment rate." Such a finding demonstrates the need to consider the economic characteristics of a region when planning transport interventions, as well as the types of patterns that may emerge in populations of interest. Considerations and challenges may include: mobility needs of shift workers, whose working hours may fall outside of traditional peak hours; ability to pay for transport services access to private vehicles; relative economic draw of a particular location; and need for subsidised services. Such considerations will be germane for a number of INCLUSION pilot sites, as they work with low-income populations.

Population and Economic Trends

The population and economic trends of an area present challenges as transport planners and others work to develop transport projects that will serve both immediate and future needs. Growing, declining, and stable areas present different challenges in terms of mobility needs, as areas work to future-proof the investments being made, both in terms of ensuring that they meet the changing needs of the population served, and in ensuring the financial stability of investments made in the short-term. For areas that are declining, ensuring the flexibility of services may be key as mobility needs may rapidly change as a population ages or patterns of travel adapt. For areas of growth, assessing the planned geographic spread of that growth, as evidenced by changes including applications for new housing development, growing school enrolment, or increases in area employment opportunities, will need to be considered when planning new areas of investment. Underlying characteristics of growth (such as employment or residential) will also impact upon decision-making, as these will influence the types of mobility services developed and implemented.

Conclusion

The characteristics identified in the literature review and associated with the Pilot sites each introduce a range of challenges that should be identified and responded to. Identification and response to these challenges will be a necessary step in ensuring that the measures

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proposed in INCLUSION match with the overall characteristics of the Pilot sites and respond to the current and emerging needs of the populations served. Considerations for prioritised area characteristics are presented in summary form in Table 2.1a, while 2.1b provides an over of characteristics of the INCLUSION pilot labs. A candidate list of prioritised area characteristics is included below, though it should be noted that these are subject to change based upon further needs identified.

Candidate Case Study Characteristics:

- Rural/remote area:
  - Deprived, hilly area in economic decline with an ageing population
  - Geographically isolated area with a seasonal economy and declining population
  - Flat area with an increasing population and mixed or improving economy
  - Accessible rural town with a growing young population and changing economy
- Peri-urban area:
  - Traditionally deprived area in economic growth, with an increasing population
  - Declining suburban area with ageing population
  - Accessible small town located in a hilly area with a stable population and mixed economy
  - Suburban area with increasing young population and stable economy
- Urban area:
  - Declining urban area with decreasing employment and population loss
  - Stable urban area with mixed employment
  - Growing urban area with increasing population and employment opportunities
  - Urban area with declining population, stable employment, and growing peri-urban areas
  - Very large urban area with stable employment and a growing population
  - Large flat urban area with declining employment and population
  - Urban area located in hilly area with stable employment and population

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Geographic	**Settlement type**	**Topography**	**Climate**
	Urban	Hilly	cool, rainy
	urban-peripheral	Flat	warm, rainy
	Suburban	Island	cool, dry
	semi-rural		warm, dry
	Rural		hot rainy summers, cold snowy/icy winters
	Remote		hot dry summers, cold dry winters
			hot dry summers, cold snowy/icy winters
			hot rainy summers, cold dry winters
Population	**Population trend**	**Demographic trend**	
	Increasing population	ageing population	
	decreasing population	increasing young population	
		increasing migrant population	
Economic	**Economic vitality**	**Economic trend**	
	deprived area	economic growth	
	affluent area	economic decline	
	mixed area	increasing income disparity	
		decreasing income disparity	

Table 3.1: General Characteristics of Prioritised Areas

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			Topography				Economic vitality				Economic & Population trends			
			Hilly	Mixed	Flat	Island	Deprived	Affluent	Mixed		Growing		Declining	Stable
Geographic area	Urban	Very large urban area		Barcelona	Budapest Florence		*Various Pilot Labs include targeted areas of deprivation within a wider mixed environment; thus, deprivation should be considered within all geographies.*		Barcelona	Budapest Florence	Budapest	Barcelona	*Several pilot labs have areas of decline contained within a larger growing or stable area; thus, we should consider areas of decline within all geographies.*	Florence
		Large urban area			Flanders (Region)					Flanders (region)	Flanders (region)			
		Other urban area												
	Peri-urban	Suburban area												
		Accessible small town												
	Rural/ Remote	Remote small towns	Cairngorms National Park	Rhein-Sieg (District)					Rhein-Sieg (District)			Rhein-Sieg (District)		Cairngorms National Park
		Very remote small town								Cairngorms National Park				
		Accessible rural												
		Remote rural												
		Very remote rural												

** Shaded areas indicate overlap between characteristics of related sites.*

Table 3.2: Characteristics of Pilot Labs

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3.2 Identification of societal trends affecting transport and mobility (RUPPRECHT (R), UNIABDN (R), MEM, EMTA (C), POLIS (C))

3.2.1 Distribution of wealth and labour market developments

Since the global economic crisis which began in 2008, Europe as a whole has steadily recovered and is currently experiencing a period of economic growth (see 2.2a). However, a number of urban-rural paradoxes have been identified related to economic growth and activity at the regional and city levels in Europe. Noticeable differences can be seen in the growth rate of GDP within countries. This is most striking in Eastern European countries, and is due mostly to the gap between rural regions and well-performing capital regions (ESPON ATLAS, 2014). Economic activity in Europe is mostly concentrated in urban regions, and the relative influence that predominantly urban regions have tends to be greater in the most sparsely populated EU member states (e.g. Bulgaria, Denmark, Ireland, Croatia, Hungary, Romania, Sweden). Furthermore, as of 2014, a higher share of people living in cities reported having an income that was 150% or more of the national median (Koceva et al., 2016).

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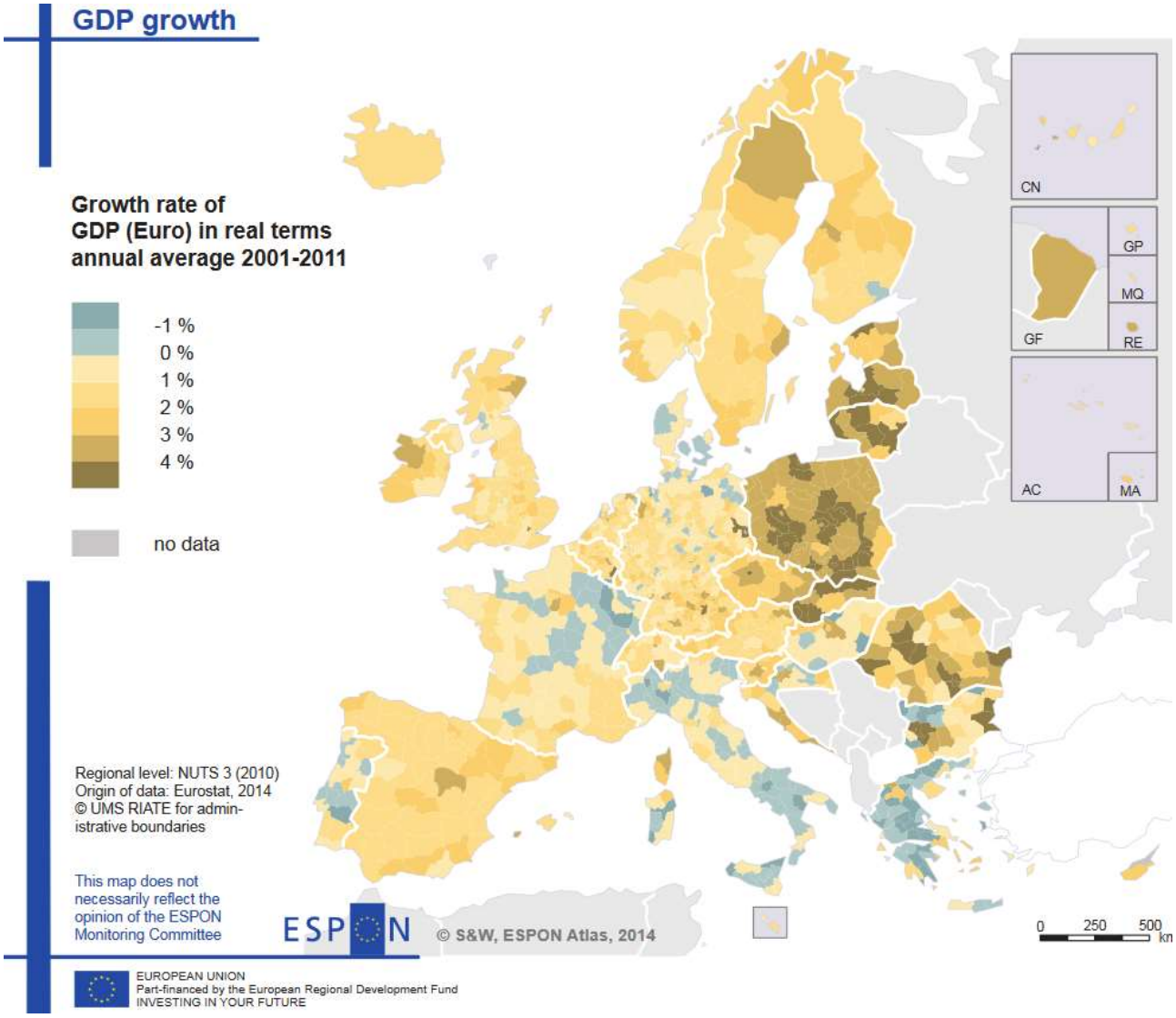

Figure 3.2: Regional GDP growth in EU 2001-2011

(Source: "ESPON ATLAS Mapping European Territorial Structures and Dynamics," 2014)

Furthermore, "the total number of persons employed keeps on decreasing in regions even showing signs of GDP growth, especially in the South and East" (ESPON ATLAS, 2014) (see **Errore. L'origine riferimento non è stata trovata.**.2b). Belgium, Poland, Germany and the Baltic and Scandinavian countries show the highest regional GDP growth rates measured by PPS. Rates are much lower in the UK, France and the Netherlands. Declining regions include many in northern England, southern Spain and Greece. A continued trend of de-industrialisation and closures has contributed significantly to unemployment in some regions (e.g. Spain, UK). Overall, employment opportunities are shifting from industry to services.

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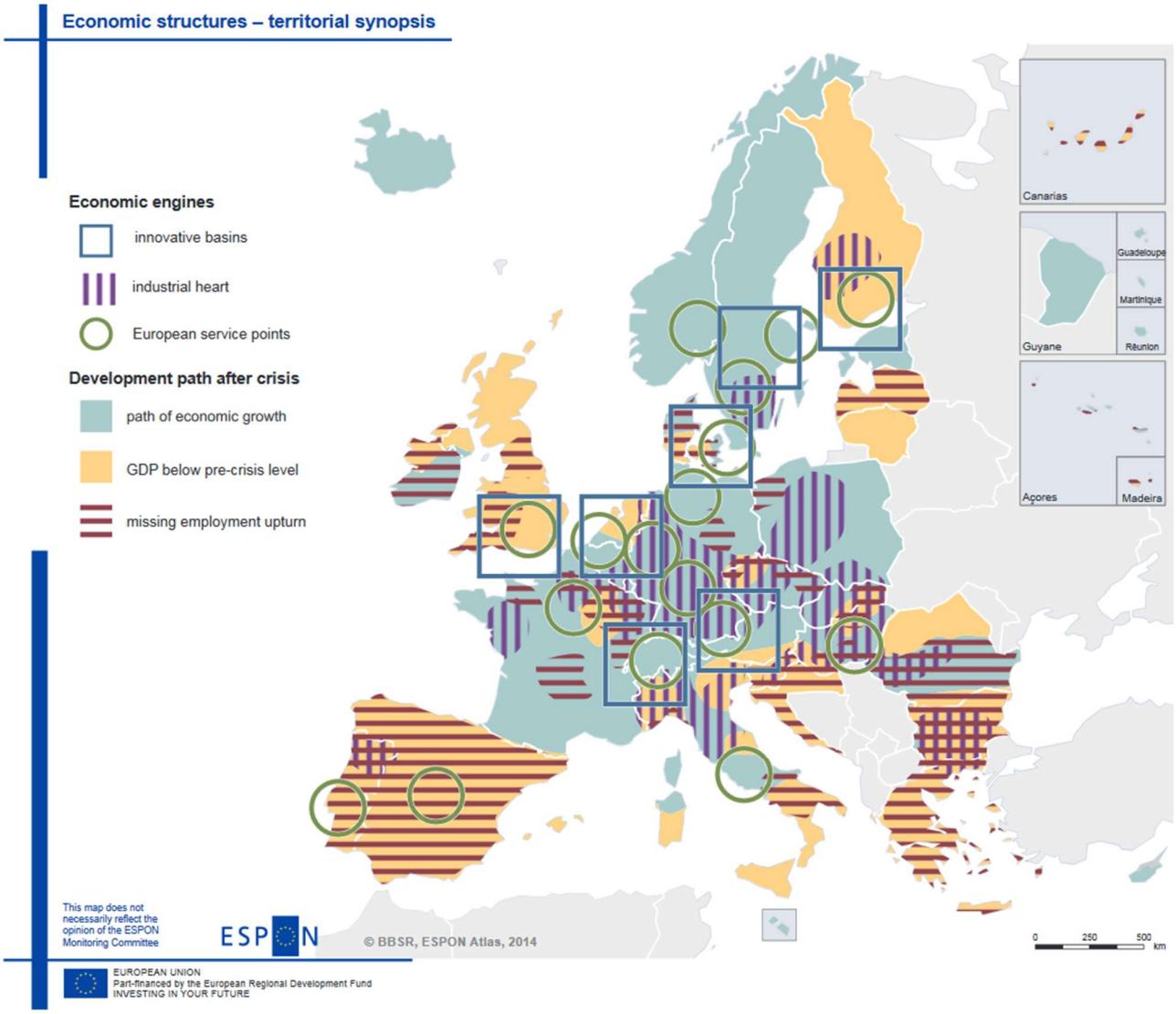

Figure 3.3: Economic structures: territorial synopsis

(Source: "ESPON ATLAS Mapping European Territorial Structures and Dynamics," 2014)

At the individual level, there is a trend towards more short-term and/or part-time gigs and fewer permanent and/or full-time jobs and tele-working, particularly amongst the younger generations. These younger generations (Generation Y, Millennials, Generation Z) are also attaining higher levels of education than previous generations. There is also an increasing number of single-parent households (usually single-mother) and "extended family" relationships.

Mobility impacts:

The economy plays a large role in shaping mobility demand and accessibility. With economic growth comes an increase in trips overall, while at the same time the changing nature of employment (including increasing unemployment in some regions, unstable employment and teleworking) leads to a decrease of peak hour commuting trips, and an increase in variable/ dispersed mobility. According to the Mobility4EU project (2016), "needs and requirements on public transport (e.g. patterns in time, frequency and distance, "peak-hours", requirements on affordability, flexibilities in

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tickets, etc.) will also change due to the shifts in economic power and shrinking middle class in the EU". 2.2c shows the areas in Europe with the greatest percentage of the population at risk of poverty or social exclusion.

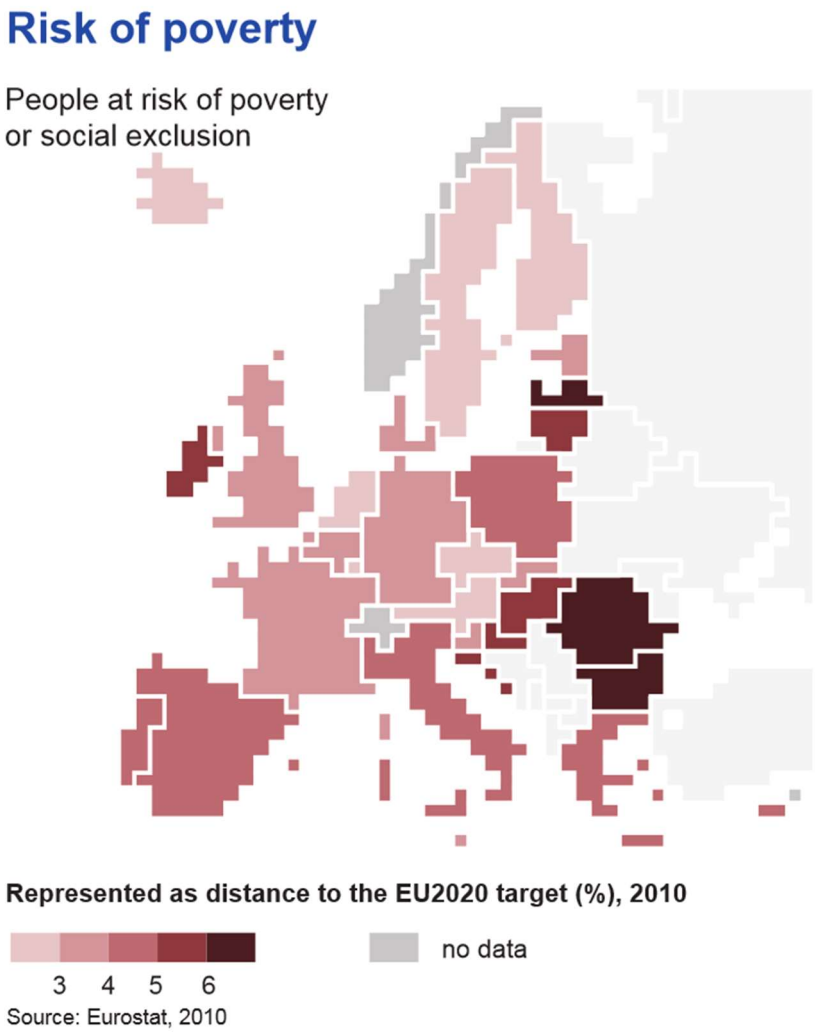

Figure 3.4: People at risk of poverty or social exclusion

3.2.2 Urbanisation

Eurostat projects that the share of the European population living in urban areas is expected to rise to just over 80% by 2050 (Koceva et al., 2016). Cities and city regions are growing in size, population and density, while at the same time rural areas are experiencing depopulation. In Eastern Europe, the pattern of urbanisation is even more polarised, with capital regions growing and second tier and smaller cities showing signs of population decrease (ESPON ATLAS, 2014). The declining cities in this region are also experiencing more urban sprawl, with population growth in the periphery and decline in the core (see 2.2d). At the same time, growing European cities are increasingly implementing smart city technologies, including Intelligent Transport Systems (ITS), to make them more efficient, convenient, safe and sustainable places to live and move within.

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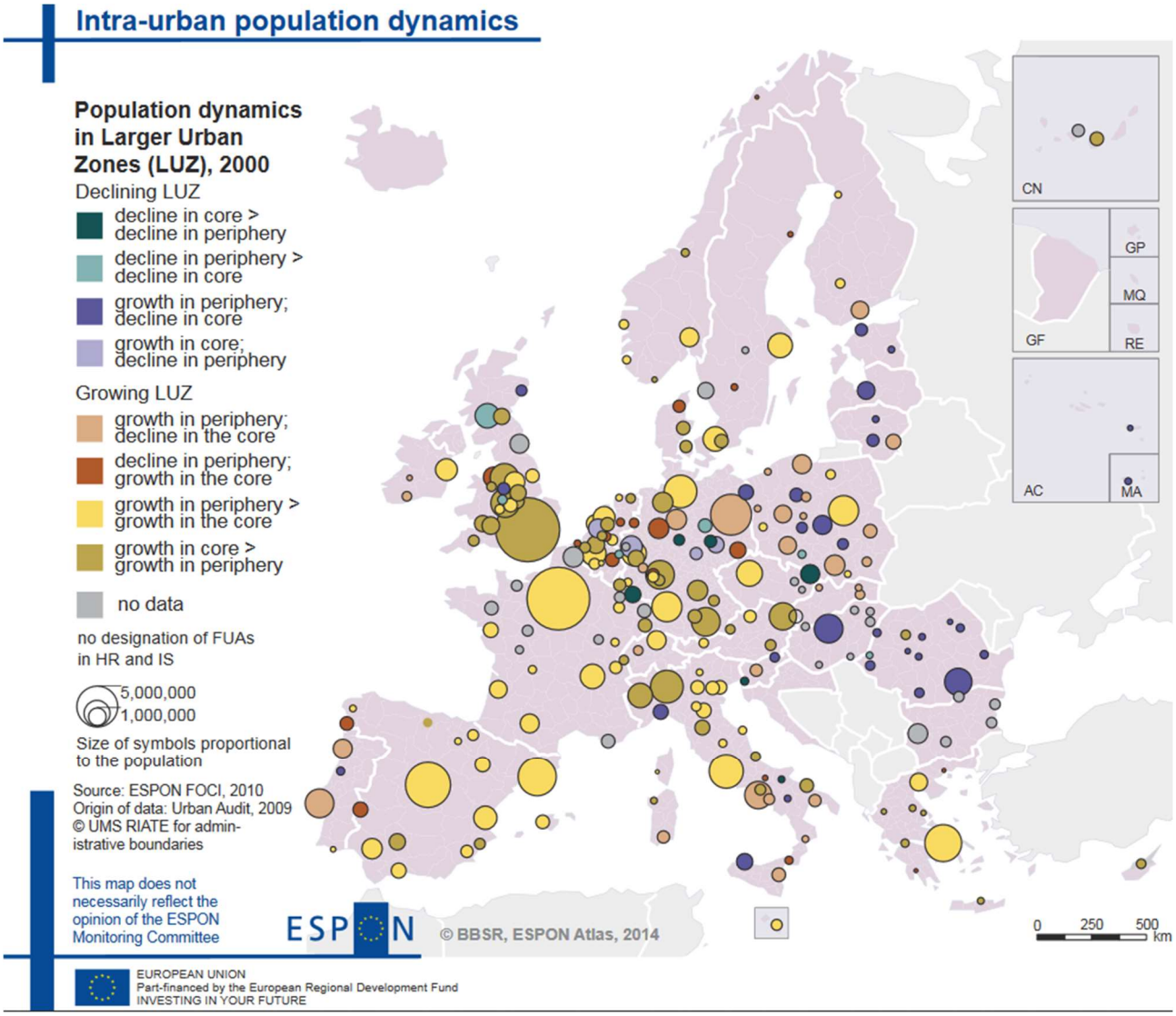

Figure 3.5: Intra-Urban population dynamics

(Source: "ESPON ATLAS Mapping European Territorial Structures and Dynamics," 2014)

Mobility impacts:

European cities' continued growth in population and geographic size has, for the most part, outpaced the implementation of transport system improvements to accommodate this growth. As travel distances continue to increase for all trip purposes, it has led to increased traffic congestion and travel times. In many cases, this is due to insufficient provision of collective transport and infrastructure for cycling and walking. Cities are experiencing overall higher but more fragmented transport demand, with longer distances being travelled for all trip purposes. At the same time, collective transport services and supporting facilities for cycling and walking are also fragmented.

Outside of urban areas, public transport providers and other new services are not expanding their services into rural areas because of depopulation. In these areas, private transport dominates the landscape and is virtually the only mobility option. Throughout Europe, there is a lack of integration

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between the primary collective transport system and last-mile, feeder and targeted services that reach into catchment areas on the periphery.

3.2.3 Environmental protection: climate change, pollution and resource and energy efficiency

Increased societal environmental awareness, especially over the past two decades, has led to more progressive regulations for environmental protection at all levels of government. EU legislation aimed at emission reduction and air quality improvement have guided national policies and consequently influenced local and regional policies, leading to the decentralisation of energy systems and a push towards renewable energies in order to reduce and eventually stop our dependence on fossil fuels. At the individual level, increased environmental awareness has led to a shift towards a "sustainable consumption" culture, thus further driving the demand for sustainable mobility options.

Mobility impacts:

In order to comply with regional and national policy regarding emissions, noise and air quality, cities are increasingly implementing traffic calming measures such as car-free zones and congestion pricing while promoting and investing in collective transport and active modes. New mobility concepts are emerging using more efficient technology to meet mobility demand, including shared mobility.

3.2.4 Changing governance models

Urban governance is becoming more integrated and transparent, with a clear trend towards "de-siloing" of policymaking. Decision makers are increasingly recognising that mobility is about much more than just transportation, and are accepting the need for mobility-related decisions to be made collaboratively by related departments and with input from participatory processes with local stakeholders, including business and civil society. This has led to greater individual empowerment and an enhanced role of end-users in the planning of public transport. Legislative models are also adapting to new transport solutions and businesses while also providing subsidies to encourage the take-up of new technologies such as e-mobility. At the same time, since the economic crisis, all levels of government have been experiencing budgetary constraints and have implemented austerity measures which have had far-reaching effects on local and regional authorities' budgets.

Mobility impacts:

Diversified approaches to governance have led to better integration of land use, urban development and transport planning. This has led to improved integration of the mobility offer in many urban areas. With greater involvement of end-users in transport planning processes comes the opportunity for vulnerable users to have more of a say in transport planning and have it reflected in the implementation of transport measures. However, many vulnerable groups are also hard-to-reach groups, which will require extra outreach efforts on the part of local and regional authorities. Meanwhile, austerity measures are directly impacting the public transport services provided and passengers transported. Areas experiencing an era of austerity are seeing reduced transport services provision and reduced budget available for social care services.

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3.2.5 Ageing societies

Ageing is a main demographic trend in Europe, along with migration (see the following section). Increasing life expectancy, coupled with an overall decreasing fertility rate across Europe, has led to a large elderly population, many of whom are in good overall health. According to the Mobility4EU project (2016), "in the 20th century it was Western and Northern Europe that had the oldest populations, but by 2060 this will be almost reversed". Across Europe, ageing is most pronounced in rural areas, while urban areas attract a higher percentage of working-age adults. As noted in the previous section on urbanisation, rural areas – especially in Eastern Europe – are also seeing a population decrease.

Mobility impacts:

Declining populations characterised by more pronounced aging are leading to a higher dependence on motorised transportation and social isolation for those who cannot or do not drive. At the same time, the elderly population of today is in better overall health and still travels on their own for daily activities and leisure. With many working-age adults moving to cities, rural areas are seeing a decrease in commuting trips and an increase in variable/ dispersed mobility.

3.2.6 Increased migration to urban regions

Migration is one of the main demographic trends in Europe. Urban regions in Europe are becoming more diverse as the pattern of migration to cities from countries within Europe and beyond continues to increase (see 2.2e). The pattern of migration within Europe is still primarily from East to West. With continued globalisation, there is also an increasing tourist flow not only to cities, but also to rural areas due to the rise of eco-tourism.

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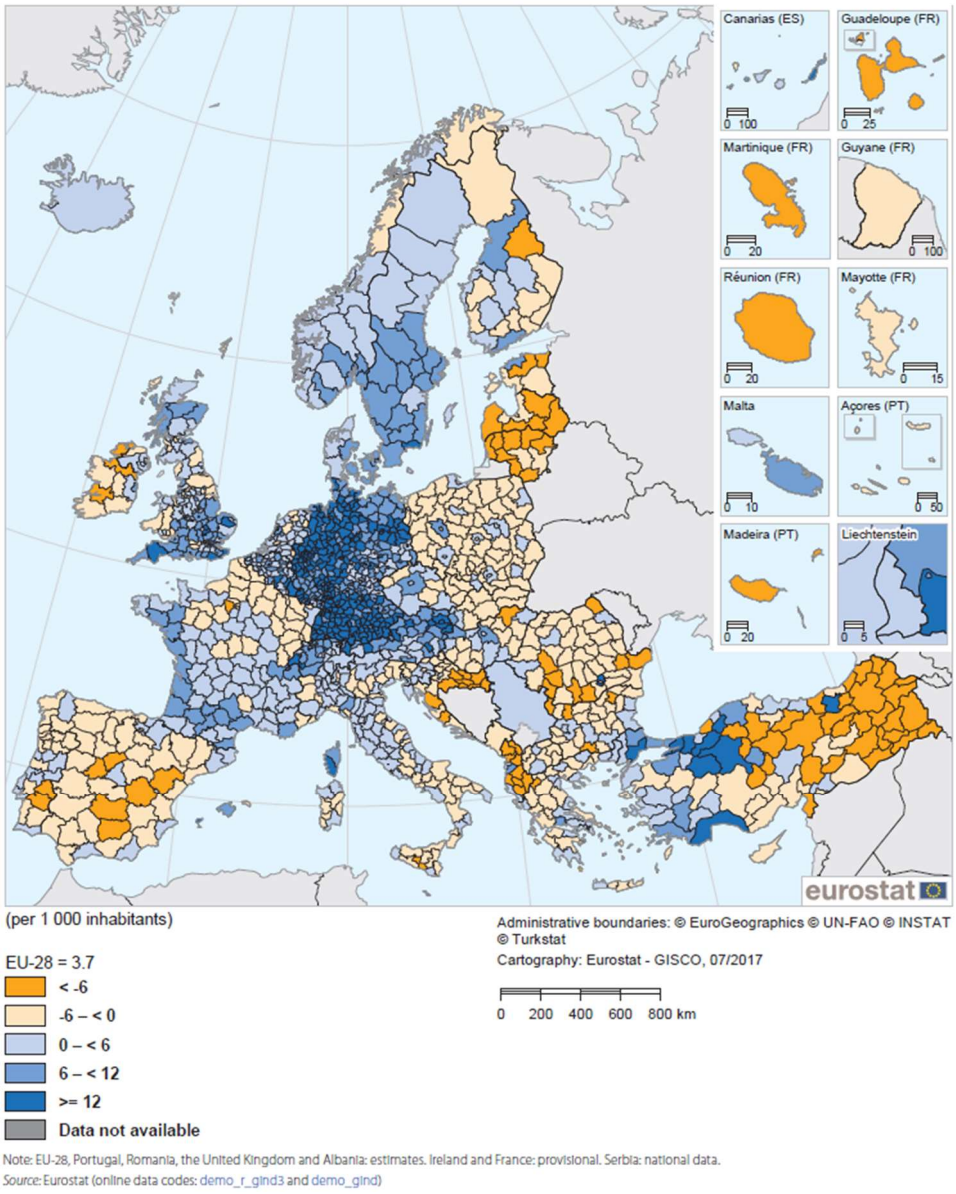

Note: EU-28, Portugal, Romania, the United Kingdom and Albania: estimates. Ireland and France: provisional. Serbia: national data.
Source: Eurostat (online data codes: demo_r_gind3 and demo_gind)

Figure 3.6: Crude rate of net migration (plus statistical adjustment), by NUTS 3 regions, 2015 (per 1,000 inhabitants)

Since 2015, a large influx of refugees has settled in Europe – primarily in Germany, Italy, France and Greece (see 2.2f). Due to the often-prohibitive cost of moving within cities, many refugees and low-income migrants are settling on the peripheries of cities. This often results in the segregation or isolation (to varying degrees) of migrants, which can continue to affect second- and third-generation migrants.

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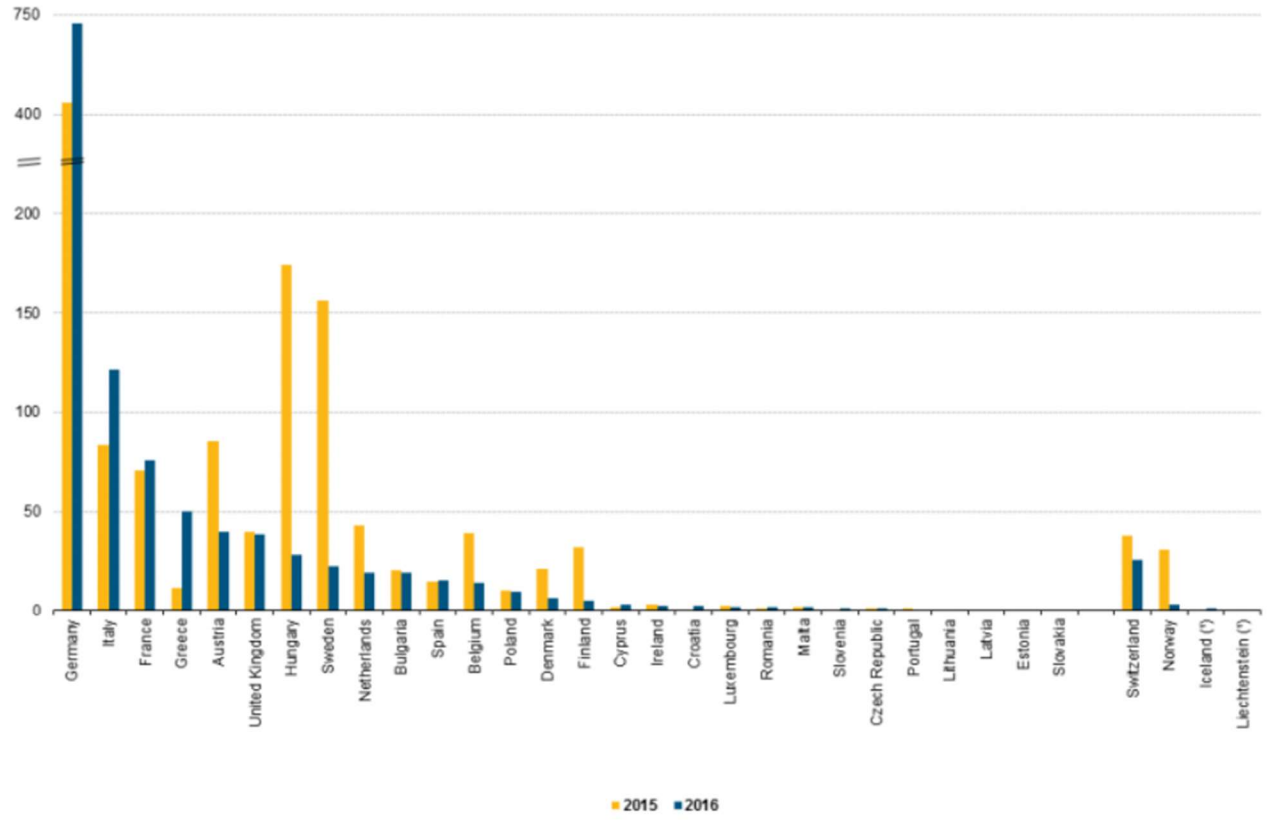

Note: the y-axis is interrupted with a different interval above the interruption from that below it.
(*) 2015: not available.
Source: Eurostat (online data code: migr_asyappctza)

Figure 3.7: Number of (non-EU) asylum seekers in the EU and EFTA Member States, 2015 and 2016 (thousands of first time applicants)

Mobility impacts:

As migration is the primary source of population increase in urban regions, it is primarily responsible for an increase in travels in terms of number, length and duration. Settlements on the peripheries of cities that are primarily comprised of migrant populations tend to also be low-income (affordable) neighbourhoods that are underserved by public transport.

3.2.7 Smart technologies and related business models

Here we aim to provide a short overview of the main trends related to the smart technologies and, consequentially, to analyse their related impacts on mobility; in addition, at the end of this section, a rapid overview of the evolution of business models in relation to the development of smart technologies (and their related impact on mobility) is presented. Section 2.5 provides a more comprehensive description of the technological trends taking place in the mobility sector, which are introduced in the following.

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3.2.7.1 Smart Technologies

Smart technologies and societal trends have had mutual influences across society. This influence is becoming even more evident as technology plays an increasingly key role in lifestyles and societal behaviour. Progress in technology influences the way of life and the approach and perceptions of service use of people by modifying their current habits, even though in some cases technology doesn't directly respond to consumer needs, but rather drives "unexpressed" needs: e. g., web diffusion or smartphone technologies. On the other hand, people ask for technological goods that provide a better quality of life (e.g.: advanced health care services, teleworking, improvement of environmental conditions, leisure, etc.).

In the following, the main relationships between the development of a number of smart technologies and the changes in societal perceptions/expectations are highlighted: the impacts on mobility (demand and/or offer side) are identified in each case.

Development of mobile technologies

In recent years, the development of mobile technologies and platforms, the expansion of communication networks (LTE, 3G/4G/5G, wireless network spots, WiMax, etc.), the growth of Internet 2.0 services and applications (enabling citizens to access services/information based on "always on" approach for time, for location and for device) and the increased use of mobile devices (i.e. tablet or smartphones) have completely changed the ways in which people communicate. These effects are felt not only among people as individuals (participation in communities, etc.) but also as citizens/customers in their interactions with organizations. The use of social media in a wide range of human activities and societal relationship (how people get information and build their perception of the world, how people participate in events in the society, etc.) is a main result of this trend. In the same way, standards for accessing information and services are changing in terms of time and accessibility. The sharing economy has also been deeply influenced by the growth of mobile technologies, along with a flexible economy and related lifestyles, which have in turn been driving factors for the growth of this lifestyle and the development of supporting technologies.

Impacts on mobility

Impacts are identified on both the demand and offer side. On the demand side, customers wish to access mobility services according to the same standards they use for other services. On the offer side, the abovementioned requirements have pushed mobility stakeholders to adopt new approaches to the management of their relationships with customers and to adapt an increasingly wider range of services for mobile technologies and platforms: from infomobility (e.g. aggregation of information, multimodal apps, etc.) to payment (i.e. mobile solutions such as SMS, QR code, NFC, etc.), from customer care (e.g. use of social media to provide information on events, answer customer requests and carry out customer satisfaction surveys) to engagement processes (e.g. on-line questionnaires). Furthermore, there has been rapid growth of MaaS initiatives that have been promoted with the aim of hiding the complexity of mobility offers (e.g. the differentiation in terms of modes, operators, etc.) from customers by providing them with an integrated offer that can be accessed based on their specific needs (which could be different day-by-day or trip-by-trip due to the flexibility of lifestyles).

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Improved performance of "virtual" and/or "remote" platforms

Due to the higher performances of communication networks and increasing computational capabilities of platforms, the architectures of technological systems are changing: sw modules to integrate, store and process data which were implemented on-site can be now accessed remotely. Innovative services to network or share resources, access data and provide added-value solutions to users/customers have been designed. The sharing economy is a societal trend pushed by the availability of these "virtual" and/or "remote" platforms enabling networking/sharing of data and resources. People are moving from "ownership" approaches to making use of devices and resources that are offered for use by others. This technological trend also supports changes in work processes (in many economic sectors), increasing their flexibility.

Impacts on mobility

Impacts of improved platform performance are mostly seen on the offer side. The availability of "virtual" and/or "remote" platforms allows for re-design of flexible PT/mobility schemes in a way that has not been fully embraced by Public Authorities/Operators, instead being primarily led by NTC providers. A wide range of innovative mobility services can be defined that combine flexible schemes already in operation with traditional technologies with new capabilities offered by "remote" platforms. Large benefits in optimizing resources and reduce costs impacts (both for investments and operation) could be achieved by exploring the possibilities for aggregating and networking different Operators in an integrated mobility offer through "virtual" platforms. New services can be more financially sustained if shared between operators or made accessible through "Service as a Solution" (SaaS)".

Improved performance of GPS technologies, big data and data mining processes

GPS signal receivers have achieved high-level performance in terms of positioning (<10 m) and availability (narrow streets, etc.), and this kind of technology is now available in lower and lower priced devices (i.e. low cost smartphones). The identification of users' current location through GPS signals has led to the growth and enhancement of "customized" and real-time access services. In a concurrent move, the possibilities for managing large quantities of data on remote platforms, collected when customers use the services, and to extract knowledge from it through data mining and learning processes has led to increased provision of "customised" information and services based on user needs and profiles.

Empowerment of the individual is the main societal trend which is related to the development of this kind of technology. This trend puts the individual in the spotlight, contributing to a move from collectivism to individualism.

Impacts on mobility

The impacts of trends noted above are felt on both the demand and offer side. Customers need easy access to information based on their travelling habits, in particular when they are commuters or regular users (e.g. to receive notification about the status of regularity of the PT line they use all the days). On the other hand, the "customization" of information and services is one of the main objectives mobility stakeholders need to achieve with the support of innovative technologies to increase the perceived quality/image of the offer.

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Crowdsourcing, Internet of Things and co-operative systems

This technological trend has been seen through combined use of increased performance of communication networks and remote platforms and the availability of new distributed architectural approaches to technology/system design. In such conditions, it is possible to have multiple data sources (e.g. the people accessing a service, the components/devices included in a system, etc.), which can contribute to improving the completeness and timely updating of information (eventually also based on a co-operative approach when information is generated by peripheral devices, transmitted to a central platform or a computational module, elaborated, and transmitted again to the peripheral devices in order to improve the quality of information managed by the whole system). These technologies implement the same schemes which have been adopted societally for networking of information and other resources. Individual empowerment is the basis of this approach, supposing that a "collective" intelligence (based on the aggregation and compensation of different contributors) provides a higher value than individual contribution.

Impacts on mobility

Impacts here are seen primarily on the offer side. Crowdsourcing tools are now being adopted into mobility models to assess travel behaviour (e.g. travel diaries), obtain feedback on the quality of provided services and assess/consolidate new ideas or service modification/upgrading. The Internet of Things is a potentially challenging technology to incorporate into traditional Intelligent Transport Services (ITS) but is currently underexplored. Despite research efforts into cooperative schemes, implementations are still at prototype level rather than at large scales (due to investment costs and the need to support technological solutions with co-operation agreements between the different mobility stakeholders involved).

Open data/standardisation

The publication of open data is strictly related to the development of mobile technologies and the availability of remote platforms. Open data contributes to network information/data among stakeholders. Trends towards standardisation have also contributed to open data publication. In addition, new job opportunities are facilitated by the publication of open data. Open data have also expanded the possibilities for developing alternative business by "non-traditional" service providers, and thus contribute to the improvement of market competitiveness.

Impacts on mobility

Impacts are primarily found on the demand side. The user can choose different solutions (e.g. infomobility apps, parking payment) covering the same area and developed by various providers.

Automation

Automation affects the way goods and services are produced and consumed, with large impacts in work distribution and organisation and in the ageing of the population. Automation is thus deeply impacting on different productive and business sectors and on evolving trends of human lifestyles. Automation can increase the quality level of services and goods provision in terms of safety, standardization and time; nevertheless, it produces relevant changes not only in the organisation of our life (e.g. work, daily activities, etc.), but also on human perceptions and ethical challenges (e.g.

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driverless vehicles in the mobility sector) which could revolutionise the principles and rules our society has established.

Impacts on mobility

Impacts here are seen on both demand and offer sides. On one hand, how users will feel about using driverless vehicles (whether privately or collectively owned) in an "open environment" and on a usual basis is uncertain. On the other hand, the role and potential of driverless solutions to manage feeder and last-mile services need to be further assessed as the technology is currently able to allow the operation of this service only in restricted or protected environments.

3.2.7.2 Business Models

Description of main trends related to evolution of new business models

The sharing economy is one of the main trends that evolved in our society in recent years. The key driver of this trend is that people (in particular, younger persons) move from the concept of "owning things" to the concept of "using things when I need them". This trend affects a wide range of activities and business such as food, tourism, mobility, etc. at a large scale, and some others such as housing, professional habits, etc. at a reduced scale. In general, the business models are evolving from "supply asset" to "offer services" as detailed in section 2.5.6 "Centralisation, transfer to e-services and withdrawal of physical presence of services". In particular, service schemes are focusing on offering people the possibility of sharing "common" assets based on their needs, which can change over time. This approach is also in line with the increasing flexibility of our lifestyles (e.g. in terms of time, habits, preferences, etc.) contributing to make ownership less sustainable/productive/ competitive.

The abovementioned trend has been supported by technological developments. Mobile networks, distributed platforms, "cloud" systems, crowdsourcing data collection networks, and cooperative technologies have all contributed to the growth of shared services offers in business practices.

In general, the business model related to these technological developments has moved from "supply systems" to "provide SaaS (System as a Service) solutions". SaaS implies that the system is not supplied to (or owned by) the clients, but rather is accessed/used as a service. These system platforms generally run on the cloud with a remote database. Peripheral devices are connected to the system platform through long range communication networks. The clients access the platform based on dedicated user profiles and they can access their own data, elaborate them and produce reports and statistics. The improved performance of long-range communication network (VPN) and the computational capabilities of distributed platforms have been factors pushing growth in SaaS solutions.

SaaS solutions are usually sold as a "service package" that includes:

- system operation/maintenance on the cloud
- management of hosting of the system on a centralised platform

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- user access to system functionalities
- a set of "base" supporting services (e.g. operator training, data maintenance, reporting, management of accounting procedures, etc.).

A set of "advanced" supporting services (e.g. support in data analysis, consultancy to use data/reports generated by the system to improve the clients' operation) is usually offered as an addition with dedicated "premium/gold" packages. Furthermore, packages may also include the cost of traffic data with the remote platform as a plus.

This business model represents a "win-win" condition when the objectives indicated in Table 2.2a are achieved by the relevant parts (system providers and clients – PT/mobility Authorities and Operators).

Objectives of System providers	Objectives of System clients
- The same standardized solution (or system configuration) can be offered to a mass number of clients (ideally the whole market). Customization for specific clients or groups should be limited - Costs required for provision/operation of SaaS must be shared among a large number of clients in order to decrease "service" price for clients - Costs required for provision/operation of SaaS allow a high level of optimization. Resources must not be dedicated to any specific client.	- Investment/operation costs to implement the system are higher than the costs of SaaS (at least in the medium term) - An alternative "breakthrough" technology can enter/is expected to enter the market in the short/medium term - If framework conditions regulating the system operation/client's needs or other events can change in the short/medium term, then the solution could not be considered the best one for the future - Supporting services provided by SaaS (operator training, data maintenance, support to solve problem in daily operation) are high quality level - Test innovative solution as pilot, assess the pilot results and decide to extend the system at full scale (eventually to move from SaaS to system implementation)

Table 3.3: System Providers and Clients

Impacts on mobility

Impacts on mobility can be identified at two different levels:

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1. innovative business models to support mobility services' schemes
2. innovative business models to offer ITS solutions.

Related to point 1), the growth of sharing services is the result of abovementioned trends in the mobility sector (as largely detailed in this Deliverable, in particular, in PART B, section 3). The parallel growth of NTC platforms is the supporting development on the technological side.

Related to point 2), SaaS solutions are provided related to the operation of:

- fleet monitoring systems (AVM/AVL)
- tools for data mining targeted to improve service planning and operation (e.g. elaboration of data collected during service operations through AVM systems)
- e-ticketing systems and payment solutions (i.e. modules to allow the management of credit cards)
- centralised platforms for vehicles systems (e.g. bike/car sharing, etc.).

3.3 Classification of the target user groups in each area type (UNIABDN (R), RUPPRECHT (C), MEM (C))

While it is critical to understand the characteristics of transport services and the geographic areas they serve, it is equally vital to understand the characteristics of service users. As described above, area characteristics will impact upon appropriate service types implemented; however, understanding the needs of users will be of equal importance when planning and implementing mobility services. One of the objectives of the INCLUSION project is, "To identify the user and social groups most exposed to transport accessibility issues and inequality in the different type of areas and undertake a comprehensive analysis of their mobility requirements." In this section, we review groups of users who may be particularly impacted upon in terms of demographics, socio-economic characteristics, behavioural segmentation, and mobility-related societal deficits.

3.3.1 Classification in terms of the demographic characteristic of user

Demographic characteristics of users may include factors such as: age, sex, level of educational attainment, marital status, family size, ethnicity, and religion. Some of these will change over time, so it is important to note that they should not be considered as static characteristics of a site population, but should instead be monitored for changes that may impact upon the mobility needs of an area. Demographic characteristics may also influence mobility needs along a variety of metrics, including not only the physical characteristics of the service type (such as low-floor buses for persons with mobility limitations or parents with young children), but also temporal structures of services (such as late-night services for young people and shift workers), and service cost. In the following section, we outline in more detail some of the ways in which these demographic characteristics may impact upon mobility needs.

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Age

Different age groups have different mobility needs, based both on physical capability and lifestyle characteristics. Children are generally heavily reliant upon their parents or other carers for mobility requirements, being unable to drive and often having limited capacity for undertaking solo trips by generalised public transport. Travel to school is perhaps the most thoroughly studied aspect of childhood travel, with a number of studies (including Grize et al., 2010; Ulfarsson and Shankar, 2008; and Easton and Ferrari, 2015) indicating that active travel to school (primarily walking and cycling) have been declining in recent years. Such declines have been attributed to a number of factors, mainly associated with physical characteristics of the built environment (such as distance to school or lack of safe route choices); however, some have also studied the relationship between parental fear of strangers with restrictions on children's independent mobility, finding a positive correlation (Foster et al., 2015). As children age into young adults, mobility options generally increase; however, they may still be somewhat restricted due to lack of a driving licence or inaccessibility of public transport options. Recent studies have indicated that there has been a decline in driving by young persons, however, potentially indicating a willingness to use alternative modes if available (Kuhnimhof et al., 2012a; Kuhnimhof et al., 2012b; van Wee, 2015). Mobility needs continue to evolve over time, as lifestyle changes occur. For example, Lazendorf (2010) looked at the impact of childbirth on mobility biographies, finding a mixed response in terms of car-orientation. As adults age into older adults, mobility needs continue to change, separate from disability status. For example, in a study of Swedish young-old persons (aged 65-79) that utilised a Capability Approach to explore use of public transport, Ryan et al. (2015) found that perceptions of functional capacity served less as an indicator as to whether a person will use public transport as to whether they will consider it. Such a finding may indicate that path dependencies established in earlier life, in addition to self-perception, will influence a person's mobility choices as they age. The physical characteristics of the area were also found to influence behaviour, with residential density also having a positive effect. Patterns of trip-making may also change as individuals age and retire; with commuting trips being replaced by travel for other activities (Mackett, 2014). Mulley et al. (2017), however, note that public transport use by older persons is low across developed nations, indicating a potential barrier to mobility access.

Sex

A person's sex may also play a role in mobility services. Given the vital role that transport-related issues such as access to jobs, education and social facilities perform in perpetuating women's disadvantaged position in some societies, it is regrettable that female perspectives have frequently been omitted from the transport sector, with public transport routes and times often inadequately suited to the needs of women who require multiple stops to carry out complex household and caretaking responsibilities (Peters, 1998). Other studies have indicated that men travel further (on average) and use cars more often than do women, despite women's travel patterns being characterised by greater complexity in terms of combining various activities (Polk, 2004; Hjorthol, 2008). However, Frandberg and Vilhelmson (2011) observed a growth in women's travel from 5-10% in 1978 to 25-30% in 2006; yet, despite this increase in women travelling for business and to work, there remains a substantial difference in travel frequency between the sexes. Widespread distinctions between men and women have been identified regarding the use and operation of transport and in broader patterns of mobility in Africa, with men owning and using commercial motorised and non-motorised transport equipment while women travel on foot (Porter, 2008).

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Disability

The notion of transport disability as put forward by Heiser (1995) discusses the nature and causes of transport disability in Britain and how to remove it. Transport disability may be thought of in different ways, for instance, a study by Porter (2002) explored two distinct areas of interest: the first focused on the nature and extent of disabled people's difficulties with transport, and the second looked into the ways in which people responded to limitations on travel and transport. Since the Heiser publication in the mid-nineties, it unfortunately remains the case that individuals who have a disability typically still face challenges in terms of transport mobility. A recent study by Pyer and Tucker (2017) reflects upon the experiences of teenage wheelchair users, in their attempts to access leisure environments. The challenges that young people in general experience when attempting to access public and private forms of transport (namely, buses, trains, taxis and private cars) are discussed; before exploring the additional 'layers' of disadvantage experienced by teenage wheelchair users including, mobility dependency, limited access to transport and transport anxiety. In contrast to studying physical disabilities and the specific mobility requirements that may stem from these, Lamont et al., (2013) considers transport accessibility for those with a specific learning disability (namely, dyslexia), for whom accessing and using travel information poses particular challenges. The recommendations put forward would assist not only individuals with learning disabilities but could also help the elderly, children travelling independently, and migrants or visitors to a country who do not speak the national language.

Migrants

A frequently overlooked demographic is that of migrant individuals; a user group who face several mobility challenges, some of which are related to socio-economic characteristics (such as having a low income), while others may arise as a result of language or cultural differences. For example, Cebollada (2009) found that the requirement for immigrants to acquire a Spanish driving licence created difficulties for those individuals who were unable to speak at least one of the languages spoken in Spain, meaning they were unable to pass the theory part of the driving test. Without possessing a valid driving licence, immigrants are reliant upon public transport or active modes, which may reduce the options available for accessing employment, education, and other facilities or services.

Students

Similar to the 'migrant' demographic category described above, students' mobility needs may also be related to socio-economic characteristics, in terms of having a low income. If students are from countries other than the country in which they are studying, they may face similar cultural issues as do migrants. An aspect which has been rarely considered is the impact on students who remain living at home for the duration of their studies due to financial, family or emotional reasons. Christie (2007) found that for students who intended to remain living at home while studying at university, their choice of courses and places to study was limited according to institutions available within the local area (i.e. a close distance from home) and availability of public transport or accessibility to other modes to take them there. In addition, the students who chose this pathway were disadvantaged by their travel patterns, due to the time-consuming nature of commuting, and also were vulnerable to any change that might affect their ability to successfully manage their study, housing, and employment.

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3.3.2 Classification in terms of socio-economic characteristics of users

Socio-economic characteristics of users may include factors such as: income level and occupation. These characteristics are often linked; with certain occupations providing higher rates of income to individuals throughout their working life, and beyond, in terms of amassed savings and higher retirement pension payments in older age. As seen in the case of demographic characteristics, socio-economic characteristics may affect mobility needs, with individuals having different transport service requirements according to income level (in terms of cost of provision, affordability, payment methods), and according to occupation (for instance, hours of employment may affect ability to use certain transport modes, which could be a particular issue around public transport fixed routes and timetables). In the following section, the ways in which socio-economic characteristics may impact upon mobility needs are outlined in more detail.

Income level

In terms of income, more deprived neighbourhoods with individuals living in poverty (i.e. urban and rural areas with a high incidence of people experiencing multiple exclusions, SEU, 1998), tend to exist with little motorised mobility, as evidenced by the low levels of car ownership, poor road connections, and limited public transport links. Barriers to the use of public transport, particularly in poor neighbourhoods, may include the cost of usage, low levels of service off-peak, reduced facilities and poor accessibility of and at interchanges and on-board (Kenyon et al., 2002). A study by Bostock (2001) explored the experience of living in a household without a car in the context of disadvantage; in particular, focusing on the ways in which a lack of car ownership restricted access to food shops, health-care services and social networks, since mothers were confined to accessing resources that were within walking distance. This was due to their having limited material resources in the form of income available to spend on public transport, and not having access to a private vehicle (Bradshaw and Morgan, 1987; Bradshaw and Holmes, 1989). This study also relates to the demographic characteristic 'parents with small children' included in the INCLUSION matrix, since the research indicates some of the mobility needs of this particular user group.

Employment

It is often thought that improved public transport provision that enables job-seekers to be connected to sites of employment will effectively link unemployed individuals to jobs. However, Sanchez et al. (2004) found that access to fixed-route public transport and employment areas had virtually no association with employment outcomes in the six USA metropolitan areas studied. This finding was supported by Cebollada (2009) who found that individuals who did not have access to a car found fewer job opportunities than persons with access to a vehicle. Furthermore, individuals who experienced mobility limitations (for instance: high mobility cost in terms of time or money; a reliance upon perceived hazardous modes or routes; a change in situation such as moving house away from an urban area; or a company relocation to a peripheral urban area) had lost job opportunities at some point during their working life (Cebollada, 2009).

3.3.3 Classification in terms of behavioural segmentation

In addition to the demographic and socio-economic variables identified above, Anable (2005) suggests that, "What is often overlooked in travel research methodology and policy interventions,

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however, is that the combination of instrumental, situational and psychological factors affecting travel choice will differ in distinct ways for distinct groups of people." In effect, basing travel behaviour research solely on aggregated or averaged characteristics of users, absent of psychological characteristics or motivations, may under- or over-estimate the contributions that various factors may make to travel decisions. By incorporating such factors as moral norms; environmental attitudes, worldview and knowledge; efficacy; identity; and habit, Anable segmented a set of 666 survey respondents into the following clusters (Anable, 2005):

- *Malcontented Motorists*: Persons who perceive a high number of constraints to public transport use, but feel a moral responsibility towards behaviour change.
- *Complacent Car Addicts*: Drivers who acknowledge that use of alternative modes is possible, but feel no moral imperative to alter their car use.
- *Aspiring Environmentalists*: Persons who have already reduced their car use for reasons of environment or health, but are reluctant to completely forego vehicle ownership.
- *Die Hard Drivers*: Drivers who are fond of car travel, believe that driving cheaply and freely is a right, and are negative towards other travel modes.
- *Car-less Crusaders*: Persons who have foregone car ownership for environmental reasons and view other travel modes positively.
- *Reluctant Riders*: Involuntary users of public transport who would prefer to travel by car.

By more thoroughly investigating these behavioural characteristics, their motivations, and likely propensity to change, it is expected that more effective messages and policies may be designed that more effectively address the underlying contributors to travel behaviour.

In a similar study conducted by Prillwitz and Barr (2011), they found consistent patterns in behavioural attributes, but expanded the factors of interest to include attitudinal factors, segmenting the surveyed population into four attitudinal clusters (addicted car users, aspiring green travellers, reluctant public transport users, and committed green travellers) and four segments reflecting daily travel behaviours (persistent car users, frequent car users, constrained public transport users, and consistent green travellers). This two-stage analysis supports findings made by Anable, but further extend this to explore context-dependency of personal attitudes, particularly by including questions of travel behaviours in daily travel or while on holiday.

More targeted segmentation analysis conducted by Hildebrand (2003) explored travel behaviours amongst the elderly, using a lifestyle clustering approach. Using factors including age, vehicle availability, income, and whether or not the individual had a disability, he identified the following socio-demographic clusters: Workers, mobile widows, granny flats, mobility impaired, affluent males, and disabled drivers. Using an activity-based analysis Hildebrand then explored the relative activity patterns of these groups, finding significant differences in travel behaviours related to type of trip undertaken, mode used, and number of trips. As above, he contends that understanding such differences has implications for policy development, as enacted policies that impact upon drivers, for example, may have an unexpectedly constraining impact upon particular segments of a population.

From these and related studies, it's critical to understand that a range of factors, including personal and household characteristics, but also attitudinal factors such as support for environmental causes or fear of crime, may have unanticipated impacts upon travel behaviours. Such impacts, in turn, may cause unintended consequences in response to policy or infrastructure investment. It is thus critical

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to look, not only at individual characteristics of travellers, but also the larger picture in terms of how these characteristics and attitudes may work together to influence the overall response.

3.3.4 Identification of user groups who are known to experience mobility-related societal deficit

The characteristics identified above will impact upon the travel choices available to and utilised by different segments of the population. These, often in combination with geographic considerations described in Section 2.1 above, may in turn contribute to mobility-related societal deficits related to well-being and opportunity. Kenyon et al. (2003) state that, "Transport is starting to be recognised as a key component of social policy, particularly in light of a number of recent studies, which have highlighted the link between transport and social exclusion, suggesting that low access to mobility can reduce the opportunity to participate in society…" Stanley et al. (2011) corroborate this, finding a significant relationship between mobility and social exclusion in both regional and metropolitan case studies, and stating that: "…risk of social exclusion may be reduced by policy and program measures that foster development of social capital, particularly in the metropolitan setting. It is noteworthy that improving mobility itself may be one way to foster development of social capital, giving trip making potentially both direct and indirect roles in reducing risks of exclusion."

Such findings highlight the need to more expressly identify the characteristics of users who may suffer unduly from mobility restrictions, keeping in mind that it is often a combination of characteristics that may contribute to varying degrees of social deficit. For example, Preston and Rajé (2007) proposed a socio-spatial schema of social inclusion and exclusion processes that included both geographic variables (area mobility and accessibility) and personal mobility measures. Such an approach provides a useful framework for identifying social deficit within the INCLUSION project, as it allows for considerations to be made of both area and user characteristics, as well as their interactions and how they contribute to overall social inclusion. Together, these can contribute to the efficacy of planned interventions, by more holistically addressing the underlying contributors to mobility-related social exclusion. A summary table of such considerations is provided below.

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		Age					
		Children	Teens	Young adults	Adults	Older adults	Elderly
Sex	Male		BC	BC			
	Female		BC	BC			
Disability	No disability		BC	BC			
	Some physical or cognitive disability	B	B	B	B, F	B, F	B, F
	Mobility-restricting physical or cognitive disability	B	B	B	B, F	B, F	B, F
Residency status	Native		BC	BC			
	Migrant	FMA	FMA	FMA	FMA	FMA	FMA
	Tourist	B	B	B	B	B	B
Student status	Student		BC	BC			
	Non-student		BC	BC			
Family status	Single						
	Adult(s) + Children/ Dependent adult(s)	CNP, RS	CNP, RS	CNP, RS	CNP, RS	CNP, RS	CNP, RS
Income level	High						
	Medium		BC	BC			
	Low	CNP, FMA, BC	CNP, FMA, BC	CNP, FMA, BC	F, CNP, FMA	F, CNP, FMA	F, CNP, FMA
Employment	Employed	FMA	FMA	FMA			
	Unemployed, looking for work						
	Unemployed, not looking for work						
	Retired						

Table 3.4: Summary of vulnerable user characteristics by pilot lab

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3.4 Mobility offers in prioritized areas: state of the art and emerging trends (MEM (R), UNIABDN (-C), RUPPRECHT (C))

3.4.1 The context for Public and Private Transport in prioritized areas

Mobility options and transport service provision can play a crucial role in mitigating the social exclusion of vulnerable and disadvantaged groups in prioritized areas (Directorate-General for Internal Policies, 2015). Providing accessible transport services for all users is a key factor in ensuring people are able to reach places of employment, leisure, education, healthcare etc. and it is very important in ensuring equal opportunities (or equity) among different communities. Different travellers have different travel needs, and for this reason it is important that the mobility offer answers exhaustively to the local mobility requirements.

Any effort to improve or transform transport services in order to strengthen and differentiate the mobility offer must consider more than just the visible services. It must also consider the key issues which shape the outcomes and which determine what is permitted or achievable (**Errore. L'origine riferimento non è stata trovata.**). These are:

- **The social and transport policies**: These consist of national, regional and local policies on the objectives, provision and organisation of public transport; any specific provisions for mobility; and any policies on mobility/accessibility for specific groups within society.
- **The organising authorities**: These consist of national ministries, local government units, passenger transport authorities, social agencies and private companies that have a role in organising transport services; and how responsibilities are allocated among them.
- **Regulatory and financing frameworks**: These consist of regulations regarding who is permitted to operate public transport services, licensing regimes, allocation of funds to public transport, programmes through which it is allocated and how this is prioritised.
- **The mobility service providers**: This consists of the mix of public and private operators who provide public transport services "on the road", the extent to which any publicly-owned operator has a dominant position, the general capacity of the operators and the extent to which they are organised and integrated.

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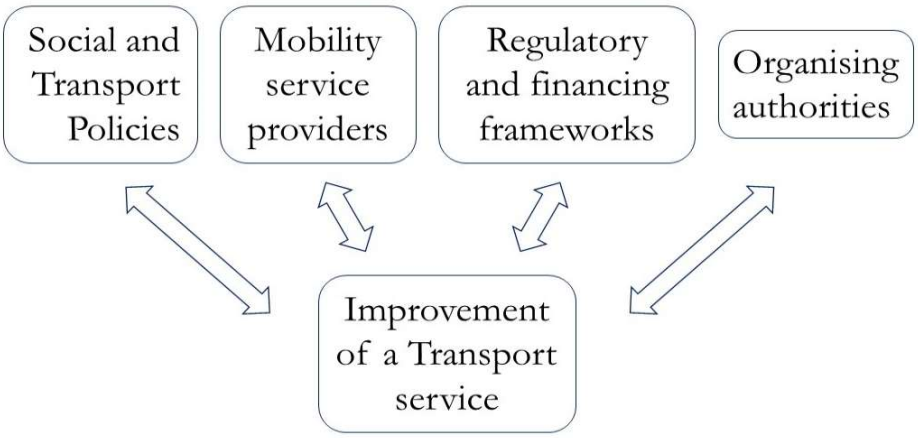

Figure 3.8: Key aspects to consider when improving (or transforming) a transport service

Source: MEMEX

The above is especially relevant for prioritized areas, where it is abundantly clear that the need for mobility exists but very often these needs are only partly satisfied or not at all. In addition, prioritized areas in one Member State can have significantly worse public transport than comparable areas in other Member States, invariably because some aspects of the framework are different.

- For example, one Member State may have a clear policy on sub-urban and rural mobility, with obligations on the local authorities and a dedicated funding mechanism; another Member State may have no such policy or funding arrangement, leaving it at the discretion of the local authorities whether to organise or provide any support to public transport.
- In the same way, some public transport solutions in some Member States are not implemented in other Member States, despite their proven success. This can occur because the regulations do not permit shared mobility in certain types of vehicle, or restrict the type of entity that may provide such services.
- The allocation of authority and responsibility for organising public transport and other mobility services varies from one Member State to another, for example whether at national or local authority level, or if it is delegated to a specific agency. This can lead to a different focus on the type of service provided, such as traditional fixed-route services with large buses in one Member State, and a mixed approach of fixed and flexible routes in another Member State.
- The responsibility and basis for providing mobility services to specific groups of people within society (e.g. schoolchildren, people with disabilities, day-care/outpatient, etc.) also varies considerably among Member States. In some Members States each group is catered for by a separate agency, giving designated

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services with its dedicated fleet. In other Member States it is more co-ordinated with greater sharing of services and resources.

It is essential to be fully aware of the differences when considering how to implement improvements, whether good practice can be transferred from one Member State to another, and whether/by whom innovative services can be implemented in a specific context.

The transport services that are presented in the next paragraphs are briefly summarised in the figure below.

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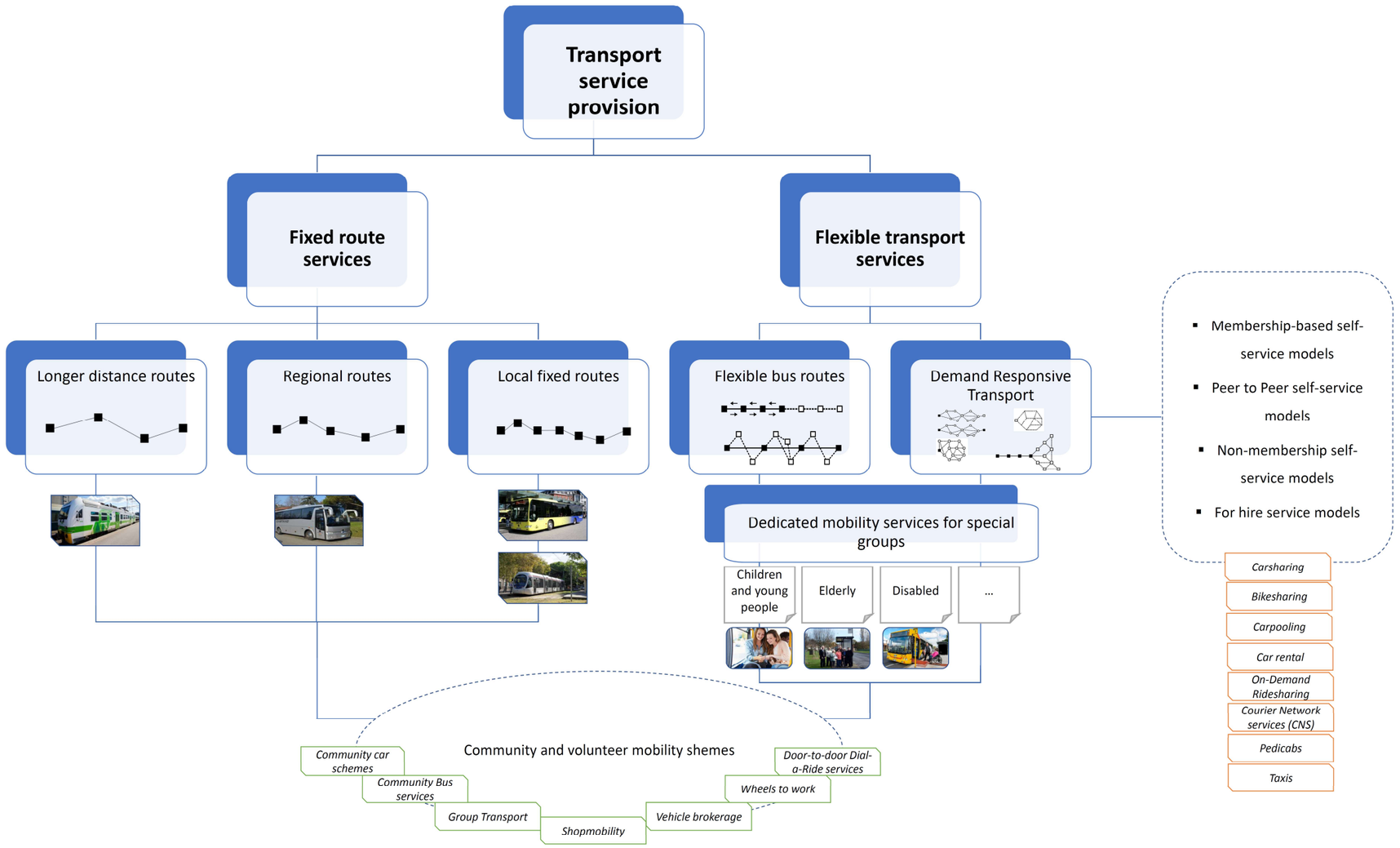

Figure 3.9: Transport service provision: general scheme

Source: MEMEX

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3.4.2 Fixed route and flexible transport services

Transport services can be defined as fixed or flexible. Table 3.6: Flexible transport services and Table 3.6: Flexible transport services summarise the different forms and related main characteristics of fixed and flexible transport services.

Fixed route transport services		
Nature	**Type**	**Coverage and Usability**
Longer-distance routes	*Long-distance rail services*	Long-distance services do not stop at smaller stations or local bus stops. Inaccessible to rural residents.
	Long-distance bus services	
Regional routes	*Regional rail services*	Regional rail services rarely stop at small stations; inaccessible to rural residents.
	Regional bus services	Regional bus services sometimes halt at smaller bus stops, for example if routes cross.
Local fixed-route	*Local rail services*	Local rail services generally stop at small stations, important service for those nearby.
	Primary bus services	Main local bus routes tend to stop at a limited number of designated stops. Convenient for those near these stops, but not for others along the route.
	Local/village bus services	Highest level of penetration and generally stop wherever there is known demand or on request. However, often have low viability and are vulnerable to service cuts.

Table 3.5: Fixed route transport services

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Flexible transport services		
Nature	**Type**	**Coverage and Usability**
Local flexible	*Flexible bus routes*	Increases the penetration and coverage area by permitting routes to deviate where there is demand; allows effective accessibility to be increased without large increase in resources
	Demand Responsive Transport	Provides highest level of coverage and usability by basing the routes around real-time demand. Can provide "door-to-door" or "near-to-near" options. If using smaller vehicles, can access rural areas with poorer road access.

Table 3.6: Flexible transport services

Fixed-route services include any transit service in which vehicles run along an established path at pre-fixed times. Trains, trams and buses are the most common examples of this type of service. Typically, fixed-route service is characterized by predefined schedules or timetables, and designated bus/terminals or rail stops/stations where passengers board and get off. Most cities and Metropolitan Areas (MA) operate public transport (PT) services along fixed routes because their communities have high population densities; frequently origins and destinations are concentrated along main arteries (on which the main PT lines run), as well as trips that are taken in peak times. Longer distance routes and Regional routes services are typically developed as fixed route services; however, in this study the focus is on rural and prioritized areas, which are often served by Local fixed/flexible routes (when the service exists).

Flexible Transport Services (FTS) introduce an innovation in Collective Transport services offer and provision, both in terms of service production procedures and target population/user groups: we pass from conventional approaches (based on fixed lines and fixed timetables) to service provision determined by real demand and service area characteristics. FTS can provide local mobility as well as connections to other conventional forms of transportation (e.g. regular bus services, railways services, etc.), being part of a larger intermodal service chain. Generally speaking, FTS can include:

- Local buses with some flexibility (routes, times, meeting points, etc.)
- Demand Responsive Transport (including Carsharing, Carpooling, Ridesharing, etc.)

In other words, Flexible Transport Services include a range of services working in urban and regional areas as an additional layer between conventional (fixed route and schedule based) transport and personal transport (car or taxi), as shown in the figure below.

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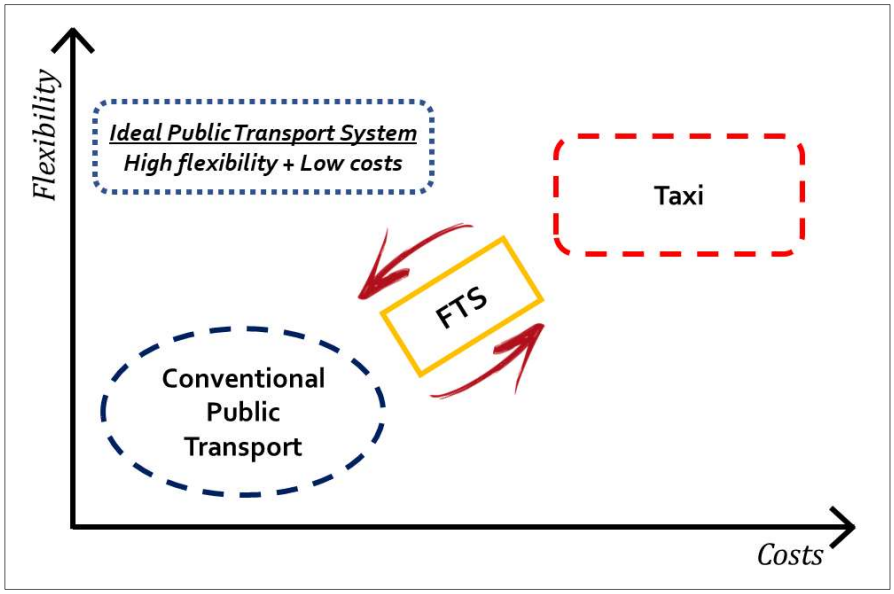

Figure 3.10: FTS within mobility services

(Source: EU Sampo project)

Generally, there are two types of FTS: general purpose, which are the services that are open to the general public, and dedicated services, which are dedicated for specific users (e.g. individuals with disabilities); in both cases, FTS can be used to gain efficiency in answering the needs of the different users when it reaches a certain level of optimization. In any case, it is very relevant for FTS implementation and long-term operation to firstly develop a feasibility study in order to define if FTS is the best solution for responding to unsatisfied mobility demand or improving users' accessibility and mobility service quality.

Flexible services typically carry only a few passengers per trip; generally more than demand-responsive systems, but fewer than would typically be required to justify a fixed-route. Operators should recognize that flexible services tend to be more similar in approach, expense, and expectation to demand-response than fixed-route services. Flexible services may be more expensive to operate per-trip than fixed-route, although savings can be realized when combining fixed-route and paratransit. However, key social and economic trends, and the support of new technologies (e.g. mobile smart phones, cloud, Internet of Things (IoT), mobile Apps, social media, etc.) can give the opportunity to break down some of the costs that sometimes affect flexible services (for example costs related to the booking of the service).

Different types of service model can be implemented. Often, the different FTS layouts tend to fall within four basic types (Luppino et al., 2014) that are shown in 2.4b:

- Scenario 1: Fixed route lines with flexible time tables. The service is based on a fixed route set on predefined stops. The trips will be carried out only if there is at least one booking by users.
- Scenario 2: Fixed route lines with on-demand deviations. The service is based on routes and timetables partially predefined; the fixed routes can be modified by user request by the inclusion of deviations on other optional and predefined stops.

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- Scenario 3: Flexible routes between predefined stops. Predefined stops mean that the vehicles can stop only at predefined points. The vehicles will have to stop in the predefined stops only if a request has been made. Area-wide service operated with the maximum of flexibility in terms of routes on a large area among defined origin/destination points (many to many). Zone service based on transfer routes towards predefined public interest points such as car parking areas, railway stations, schools, hospitals, etc. ("many-to-few").
- Scenario 4: "Door-to-door" free routes. The stops in "door-to-door" services are non-predefined as they are passenger specific points. This set of points is composed of all the possible requested places (usually the users' places of residence and points of interests such as schools, shopping centres, hospitals, health centres). This service (door-to-door) is quite similar to a taxi service; the exception is that there may be several destination doors before a passenger's own door.

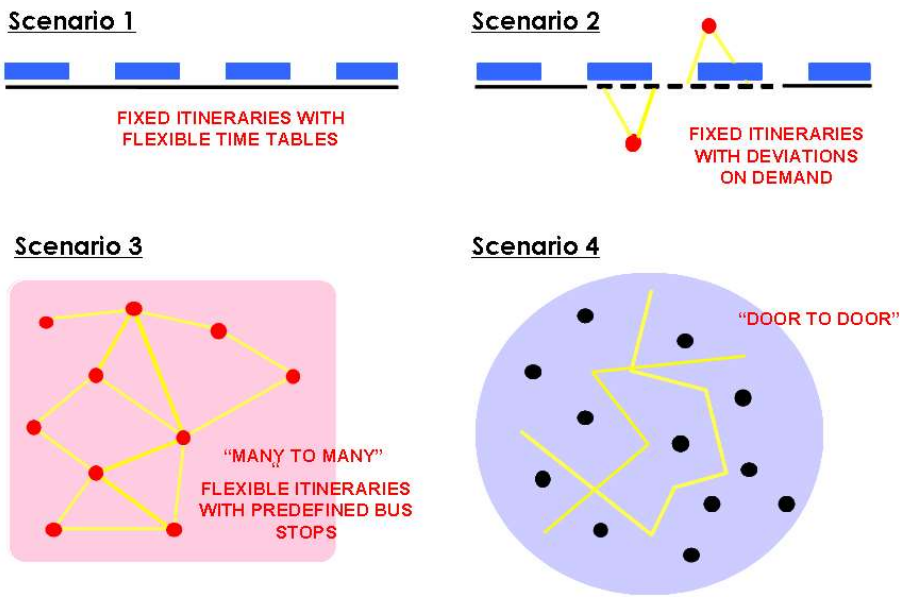

Figure 3.11: Basic service types for FTS layout

(Source: Transnational case study, 2014)

The choice among these schemes depends on different options such as area geography, existing transport networks, demand typology, residents' typology, type of services, etc. In some cases it is possible to use more than one scheme in order to satisfy the needs of different users' typologies.

The "door-to-door" service is clearly an extreme view of the PT service (unlimited and without predefined numbers of O/D points). This scheme could provide benefits only if applied to specific user categories (like disabled or elderly people) however limited.

The above-mentioned service model can be articulated in a wide range of schemes, presented in Table 3.7: Service models of FTS.

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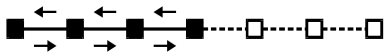
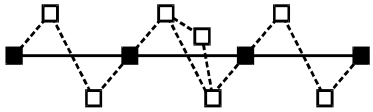
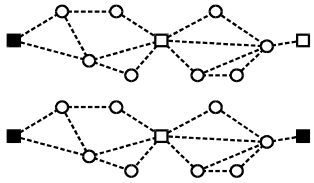
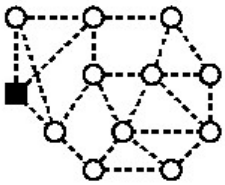
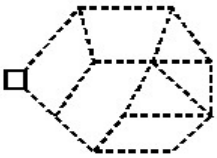
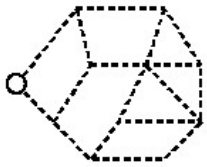
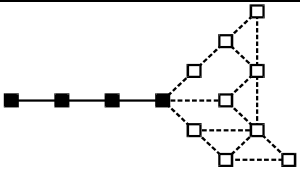
Schemes	Description
	Fixed corridor service with scheduled time and routing (conventional services)
	Semi-fixed corridor service with fixed start/end points and intermediate points and deviations when requested by passengers
	Flexible corridor service with fixed start/end points and stops when requested by passengers within a transport corridor
	Flexible area service with predefined stops when requested by passengers and fixed start/end points
	Flexible area service with predefined stops when requested by passengers, fixed start/end point and main stops with scheduled timetable of transit
	Flexible area service with predefined stops when requested by passengers or non-predefined (doorstep) stops
	Integrated service schemes between conventional lines (scheduled time and routing) and DRT area

Table 3.7: Service models of FTS

Public transport services have traditionally been designed to guarantee the mobility of people in relatively urban areas, where travel patterns and volumes enable service along fixed routes to follow predetermined schedules. In rural and sub-urban areas, where the population density is lower, transport service provision offered by PT operators is reduced, and this reduction can imply a lack of mobility and potentially social exclusion, especially for those user groups with limited access to a private car. Recently, however, growth patterns and social changes have led to more dispersed

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demand and to traffic congestion that has grown considerably causing much concern by various governmental and professional institutions. Where public transport operators once had well-defined downtown cores and could provide networks that served them effectively, the environment within which public transport exists now includes multiple centres, lower overall densities, and multiple origin/destination pairs. Many urban transport providers are now faced with the problem of declining ridership on traditional fixed route services in low density suburban areas. As a result, most fixed route services in such areas are not economically viable for the transport provider. As such, there is a need for the public transport service to adapt to these changes and find solutions to enhance the performance of public transport services in suburban areas.

3.4.3 DRT, on-demand services and shared mobility solutions

Advancements in social innovation, location-based services, the Internet, and mobile technologies have contributed to a sharing economy, as described above in Section 2.2.7. Among these trends, Shared mobility (vehicle and/or ride/trip) is one facet of the sharing economy. Shared mobility enables users to obtain short-term access to transportation as needed, rather than requiring ownership.

Shared mobility includes a range of different services that can be put together under the heading 'Paratransit' (more often referred to as Flexible Transport System or Demand Responsive Transport). In the literature, the term Paratransit has usually referred to all transport services included between a taxi and conventional public transport. According to Vuchic (2007), Paratransit can be characterised as being "Urban passenger transport service mostly in highway vehicles operated on public streets in mixed traffic; it is provided by private or public transport operators and is available to certain groups of users or to the general public; but it is adaptable in its routing and scheduling to individual user's desires in varying degrees". Paratransit services include: Demand responsive transport (DRT); Organized commuter ridesharing: carpooling, bus-pooling, and vanpooling; Car sharing; Taxi services and ridesharing schemes. Four types of paratransit service can be identified (Enoch et al., 2004):

- Interchange services which have evolved to act as feeder services to enable people living in relatively low-density areas to access higher frequency bus and rail-based services;
- Network services which differ in that they enhance public transport either by providing additional services, or by replacing uneconomic services in a particular place or at certain times;
- Destination-specific services which have been developed to serve special destinations such as employment locations or airports.
- Substitute paratransit which effectively reinvents public transport by replacing conventional public transport rather than complementing it. For example, the DRT operated in different rural areas (or low demand areas) organised around a travel dispatcher centre (automated or manual) for booking trips in advance (period to be defined on the basis of the financial and organizational dimensions).

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Demand responsive transport (DRT) is a subset of paratransit and of FTS, where smaller vehicles (passenger cars, vans, minibuses) are operated on-demand in response to calls from passengers (or their agents) to the DRT operator. Vehicles are dispatched to pick up the passenger and transport them to their destinations in a shared-ride mode, door-to-door, kerb-to-kerb, stop-to-stop, or combinations thereof. A more or less advanced ICT support system is used to manage and co-ordinate the operations (Westerlund, 2016). A demand response (DR) operation is characterized by the following (USNTD, 2012):

- The vehicles do not operate over a fixed route or on a fixed schedule except, perhaps, on a temporary basis to satisfy a special need;
- Typically, the vehicle may be dispatched to pick up several passengers at different pick-up points before taking them to their respective destinations and may even be interrupted on route to these destinations to pick up other passengers.

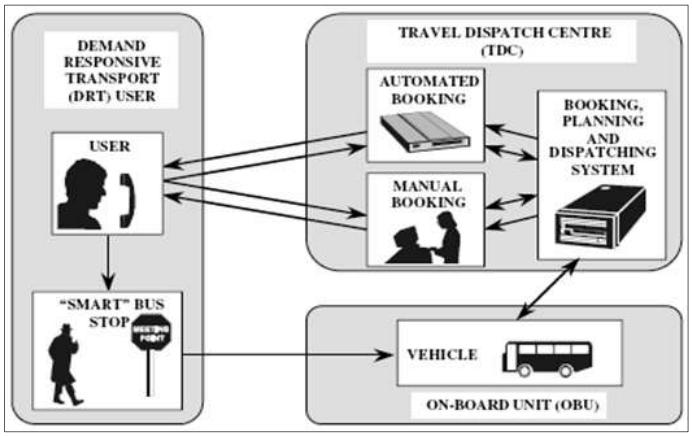

Figure 3.12: Illustration of DRT Service and Operation

(Source: Mageean and Nelson, 2003)

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According to the U.S. Department of Transportation's Federal Highway Administration, there are various service models and transportation modes to meet the diverse needs of users (FHWA, 2016) See Table 3.8: Shared mobility service models.

Membership-based self-service models	Peer-to-Peer (P2P) self-service models	Non-membership self-service models	For-hire service models
- Bikesharing *-Carsharing* *-Carpooling* *-On-Demand Ridesharing* *-Scooter Sharing* *-Vanpooling*	*-Bike/scooter sharing* *-Carsharing* *-Van-sharing*	*-Bikesharing* *-Car Rental* *-Casual Carpooling*	*-Courier Network Services (CNS)* *-Liveries / Limousines / Pedicabs* *-Ridesourcing / TNCs* *-Taxis/E-Hail*
			

Table 3.8: Shared mobility service models

Membership-based self-service models

Membership-based self-service models contain five common characteristics:

1) an organized and registered group of participants;
2) one or more shared vehicles, bicycles, scooters, or other low-speed mode;
3) either a decentralised network of pods or stations used for departure and arrival for roundtrip (motor vehicle, bicycle, or other low-speed mode is returned to its origin) or station-based (vehicle, bicycle, or low-speed mode is returned to different designated station location) one-way services or free-floating (motor vehicle, bicycle, or low-speed mode can be returned anywhere within a geographic area) decentralised vehicle network with flexible departure and arrival locations typically within the confines of a fixed geographic boundary;
4) short-term access typically in increments of one hour or less;
5) self-service access.

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In addition to one-way and roundtrip service models, membership-based self-service models can be deployed as either "open systems" available to the public or "closed community systems" with limited access to predefined groups, such as members of a university community, residents of an apartment complex, or employees of a particular employer or office park.

Peer-to-Peer (P2P) self-service models

Carsharing and bikesharing have also given rise to peer-to-peer (P2P) systems that enable vehicle and bicycle owners to rent their vehicles and bicycles to others when they are not in use. In P2P service models, companies broker transactions among car, bicycle, or other mobility owners and renters by providing the organizational resources needed to make the exchange possible (i.e., online platform, customer support, driver and motor vehicle safety certification, motor insurance, and technology). P2P services differ from membership-based self-service carsharing or bikesharing in that the operator owns the private vehicles or bicycles being shared. Similar to carsharing and bikesharing, P2P services also have their own niche markets.

Non-membership self-service models

Non-membership self-service models include rental cars, carpooling and bikesharing.

Car rental is a non-membership-based service or company that rents cars or light trucks. Traditional rental car services include storefronts requiring an in-person transaction with a rental car attendant. However, rental cars are increasingly employing "virtual storefronts," allowing unattended vehicle access similar to carsharing. Historically, rental cars have focused on three different service models: 1) airport-based rental services located at air terminals (e.g., Hertz, Avis, Europcar, and others); 2) neighbourhood-based rental services (e.g., Enterprise); and 3) truck-based rental services (e.g., U-Haul, Ryder, and Penske).

Car rentals are generally priced on a daily or weekly basis, often with differing rate structures for leisure and commercial use. In addition to base rental rates, most car rental companies offer ancillary and a la carte charges for a variety of products and services, such as car seat and GPS rentals and increased insurance coverage.

Carpooling is a formal or informal arrangement where commuters share a vehicle for trips from a common origin, destination, or both, reducing the number of vehicles on the road. Over the years, carpooling has expanded to include a number of other forms. Casual carpooling or "slugging" is a term used to describe informal carpooling among strangers, which has often been referred to as a hybrid between commuter carpooling and hitchhiking (e.g. BlaBlaCar). With slugging, passengers generally line up in "slug lines" and are picked up by unfamiliar drivers who are commonly motivated to pick up passengers to take advantage of high-occupancy vehicle (HOV) lanes, lower tolls, and similar benefits. In addition, the growth of the Internet and mobile technology has enabled online ridesharing marketplaces, such as Carma Carpooling, where users can arrange ad hoc rides typically on-demand or with minimal advance notice through a personal mobile device. Carpooling can include a small donation to the driver to reimburse costs (e.g. fuel, tolls, parking), but it cannot result in financial gain without bringing about insurance and other regulatory challenges.

For-hire service models

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For-hire service models include pedicabs (a for-hire tricycle with a passenger compartment), ridesourcing, taxis, limousines, or liveries that carry passengers for a fare (either predetermined by distance or time travelled or dynamically priced based on a meter or similar technology). The fundamental basis of for-hire vehicle services involves a passenger hiring a driver for either a one-way or a roundtrip ride. For-hire vehicle services can be pre-arranged through a reservation or booked on-demand through street-hail, phone dispatch, or e-Hail using the Internet or a smartphone application.

3.4.4 Dedicated mobility services for special groups *(for example, healthcare, education)*

To meet the different needs of special groups, there are several transport services that are specifically dedicated to different users. These services are adapted to local user needs and can be considered as an additional service that strengthens the transport service provision by addressing specific requirements of users. Some examples of special services related to children, disabled and elderly individuals are presented in the following paragraph.

Children and young people

Young people, especially students, rely heavily on public transport, of which they are the most frequent users: 67% of European students use public transport at least once a week (as compared to a total population average of 32%) and 49% every day (against a total population average of 16%) (European Commission, 2016).

Figure 3.13: Young people on public transport

Source: Public News Service, 2015

Barriers to accessing public transport can socially disadvantage children and young people. Indeed, poor availability and high public transport fares may hamper access to education, cultural and leisure activities, and, for young people, jobs (DGIP, 2016).

The most common transport services specifically dedicated to children and young people are the ones serving the routes between home and schools. The service models related to these services can be categorised into two groups:

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- Organised school transport routes

These services establish special routes for schoolchildren to connect peripheral and rural areas to designated schools; usually the service operates only to/from the school at the start/end of the school day and only at a predetermined time. Sometimes these services are restricted to registered schoolchildren;

- Self-organised school buses

These services for schoolchildren are organised privately by the schools or by parents.

Elderly

Older people are usually regarded as a group with particular limitations and needs, especially in terms of mobility. Some older people are also more susceptible to poor health, which can limit their autonomy and independence – including freedom of movement; old age may come with physical and/or sensory impairments, such as hearing and vision loss, and/or reduced capacity in terms of mobility and walking. Moreover, the elderly may face an increased risk of mental health problems and cognitive impairment, reducing their independence and mobility. Indeed, old people belong to the category of people typically defined as transport-disadvantaged in the transport-related literature.

Figure 3.14: Elderly persons waiting at a bus stop (England)

(Source: GazetteLive, 2014)

In order to keep older people actively involved in their daily activities, it is vital that they are able to travel and have access to acceptable levels of mobility. Factors such as long-term illness or disability, social isolation and lack of independence make older people a group at risk of becoming socially excluded.

Older Europeans are likely to use urban public transport in particular for leisure activities (e.g. shopping, visiting friends and relatives) (European Commission, 2014); they also use public transport to take grandchildren to school and to other after-school activities and to access healthcare facilities

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(SIZE Project, 2006). The various alternative transportation services related to elderly are briefly summarised and described in Table 3.9: Transportation services related to the elderly.

Transportation services related to elderly	
Type	**Description**
Volunteer Driver Programmes	Local faith-based and non-profit organisations frequently have a network of volunteers who offer flexible transportation for shopping, doctors' appointments, recreation, and other activities. One-way, round-trip, and multi-stop rides are usually available; reservations are needed. These programmes are provided free, on a donation basis, through membership dues, or for a minimal cost (National Association of Area Agencies on Aging, N.D.). Social service organizations often provide fare assistance programmes that enable qualified persons (usually economically disadvantaged older adults or persons with disabilities) to purchase vouchers for transportation services at a reduced rate that are used to pay for services
Paratransit Service	Public transport, aging organizations, and private agencies provide door-to-door or kerb-to-kerb transportation using mini-buses or small vans (vehicles for less than 25 passengers). Paratransit service often requires users to make advanced reservations but still offers a degree of flexibility and personalization in scheduling. Kerb-to-kerb service provides for passenger pick-up and delivery at the kerb or roadside; door-to-door service offers a higher level of assistance by picking up passengers at the door of their homes and delivering them to the doors of their destinations. Paratransit and van services offer reduced fares for older adults and persons with disabilities, and some providers may operate on a donation basis.
Door-through-Door Service	Agencies provide drivers who offer personal, hands-on assistance by helping passengers through the doors of their residences and destinations, as needed. This type of service includes several levels of assistance from opening doors and providing verbal guidance, to physical support. Persons with severe physical or mental disabilities typically use this service.
Taxi service	Passengers activate this service by calling a dispatcher to request a ride between locations of their choice. Trips usually can be scheduled in advance or on the spot.. Fares are charged on a per-mile or per-minute basis on top of a base charge for each trip, and may be payable through a transportation voucher programme.

Table 3.9: Transportation services related to the elderly

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Disabled

In making transport systems accessible, disability described in functional terms is usually a more useful measure than medically based impairment. Thus, the inability to climb steps higher than 25cm can be caused by many different medical impairments but it is the functional limitation that must be considered in the design of a transport system.

Article 1 of the Convention on the Rights of Persons with Disabilities – Optional Protocol - states that "Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others."

Considering disability both in physical and functional terms, in Europe, 12 to 14% of the population are disabled and the percentage of people with disabilities increases with age. Accessible transport must provide much more than vehicles that can be used by a person in a wheelchair; it also requires knowledge, ability, financial means and confidence. Staff training, positive attitude and the willingness to help can overcome many deficiencies of vehicle, infrastructure or supply of information (United Nations Development Programme, 2010).

Figure 3.15: Assistance for boarding a bus

(Source: Adelaide Metro website)

Access to transport is increasingly recognised as having a significant impact on the quality of life and independence of people with disabilities, as they have specific mobility problems. The disabled may be less likely to benefit from access to standard means of transport if they are not designed taking their needs into account. In fact, the single most frequently used mode of transport by disabled persons is the car as passenger (DPTAC, 2002), while public transport is less used, as shown by a recent Eurobarometer survey (European Commission, 2014).

There are several specialised services that are specifically tailored to the needs of passengers with disabilities. Specialised services usually use vehicles that provide full access to wheelchair users through mechanical lifts or ramps, and differ from regular public transport in the way they are operated. Services range from door-to-door services that exclusively serve disabled people, to 'Service Routes' (which serve the general public but are specifically routed to travel close to the origins and destinations of elderly and disabled people). Accessible (metered) taxis, although not a

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specialised service, are also used to provide kerb-to-kerb services for disabled people. The use of specialised transport services acknowledges that regular public transport cannot serve the needs of all disabled people: for example, many are unable to walk to, board, or travel independently in public transport vehicles due to the severity of their impairments. On a per passenger basis, specialised transport services are usually more expensive to provide than accessible regular public transport, and such services are often funded publicly to complement conventional public transport.

According to the United Nations Development Programme (2010), key issues which determine the best services to meet the special needs of disabled people are:

- **Safety:**
  - Vehicle design and features are safe to avoid injury.
  - Lifting equipment and ramps designed and operated safely to avoid injury.
  - Vehicles driven smoothly and considerately.
- **Reliability:**
  - All advertised accessibility features available and working.
  - Driver/staff provide helpful service and special assistance where needed.
- **Accessibility:**
  - Easy and unhindered boarding via steps (if any).
  - Level boarding for wheelchair users into vehicles.
  - Hand grips and steps highly visible.
  - Easy stowage of mobility aids (wheelchairs, guide dogs, walkers).
  - Signage identifying vehicles and specialised service.
  - Call-in telephone service and booking services for reservations or queries (if any)
  - Alternatives to telephonic booking.
- **Affordability:**
  - Affordable fare for targeted passengers with disabilities.

The following classification of the different on-demand services related to people with disabilities has been directly taken by the report of the United Nation Development Programme (2010):

1) Individual transport

This is the group of services that provide transport for an individual (plus companion) door-to-door. They fall into two categories; voluntary car schemes and accessible taxi schemes.

Voluntary car schemes, in which the passenger is carried in a volunteer's own car, are quite widely used for taking people to out-patient treatment at hospitals. The volunteer will usually be paid a mileage allowance to cover running costs of the vehicle, while the service is free to the user. Such

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services can be very useful in rural areas where conventional modes of transport, accessible or otherwise, may be thin on the ground. These services, since they rely on the cars owned by volunteers are not appropriate for wheelchair users who cannot transfer from their chair to a car seat, though quite a lot of wheelchair users can transfer and so use ordinary cars. Some community transport services also provide a car service with a vehicle adapted to carry a passenger in his/her wheelchair.

Accessible taxis can, of course, be used by any disabled person provided they can afford the fare. For many disabled people, the fares are more than they can afford. To help overcome this problem various schemes have been introduced to make taxis available to disabled people at a heavily subsidised rate.

Providing a service of this kind can be expensive for the funding authority (local and/or central government) so it is important to try and ensure that the people using it really do need it. Some form of eligibility criteria should be used and even then it is very likely that it will be necessary to impose an upper limit on the number of trips any one individual can make in a given time.

An accessible taxi-based service for disabled people can be more cost-effective than a shared-ride demand-responsive minibus service. In planning and developing these types of service, it would be prudent to consider all the forms and systems; the most effective, in terms of use of resources and delivery of a good level of service to the individual, may be found by a combination of services rather than just one.

2) Shared transport

Often known as Dial-a-ride or Dial-a-bus, this service also provides door-to-door service, using minibuses which should be equipped to carry passengers in wheelchairs. They are booked in the same way as taxis and the theory is that the control office for the service will be able to organise the requests for trips in such a way that more than one individual is carried at the same time. This shared ride concept, if it could be achieved, would reduce the cost per passenger carried, in theory to less than the cost of an equivalent taxi journey.

In practice this often does not happen, with the result that the cost per passenger trip is higher than the equivalent taxi trip. However, taxi drivers cannot be expected to exercise the level of special care and assistance needed by some disabled people. Dial-a-ride drivers will not only assist passengers from their door to the vehicle, but may also help them to finish dressing.

3) Community transport

This is the category of services, again usually using lift-equipped minibuses, which provide collective transport for disabled people. They will provide a service from an individual's home to a facility such as a day-centre or luncheon club or to an accessible town centre for shopping. They cater for individual requests for a journey, but take individuals to a collective or joint activity.

Community transport services are usually funded, at least in part, by local government and are available for use by a wide range of people, not just disabled or elderly. It is their general availability which distinguishes them from the host of transport services provided by disability associations for the use of their own members.

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Although these services are specific in the sense that they are provided by and for the members of a specific association, they nevertheless represent a transport resource which may not always be used in the most effective way. When considering the planning and provision of special services, it is always sensible to include these "disability association" services in the planning process.

4) Hybrid services

Between the special services, of the types described above, and mainstream public transport services, there is scope for services which, while not being exclusively designed for disabled people, nonetheless offer a level of service beyond that normally associated with conventional public transport.

These services are designed to overcome the problems older and disabled people may have in using accessible mainstream bus services, which are walking to and from bus stops, waiting at a stop, moving quickly to board and pay a fare, moving quickly to alight and possibly having to stand during a journey. The attributes of the Service Route class of service can be summarised as:

• Uses fully accessible buses, usually medium-size dimension;

• Timetabling of the service which allows more time at stops than on a conventional service;

• Routing of the service to serve places where there will be numbers of disabled passengers – residential homes, clinics, day centres, etc. This reduces walking distances to and from stops, at the expense of a longer route and a slower journey;

• Flexible pick-up/set-down points – hail stop where appropriate and possibly a degree of route diversion;

• Well trained drivers (and other staff).

3.4.5 Location-provided mobility services

Location-provided mobility services may refer to location-based services (i.e. services typically offered through a mobile phone or other location-enabled device that consider the device's geographical location) or to the providers of the information that seeds such services. The rapid emergence of personal technologies such as smartphones and tablets, along with the underlying data and communications architecture that enable on-demand and personalised information to be obtained, have served to facilitate many of the services outlined above, as well as contributing to emerging models of mobility provision such as Mobility as a Service (MaaS), app-enabled lift sharing, and crowdsourced mobility information. Miller and Shaw (2015) highlight such applications when they state, "The development of demand responsive transport services in the past operated mainly as an advanced reservation system rather than a (near) real-time demand responsive system. This has changed with smartphone apps and on-demand mobility services such as Uber and Lyft. Many bikeshare systems also have real-time station status apps, and public transport services are sharing their schedules and vehicle GPS feeds with developers and the public. These online apps provide better means to match supply and demand in (near) real time and could contribute to a more

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sustainable transport system by allowing users to stitch together appropriate mobility services and depend less on private automobile ownership." Key to this argument is the belief that information may facilitate behavioural change by, for example, reducing uncertainty, increasing convenience, or alerting travellers to options of which they were previously unaware.

With such potential benefits, however, also comes the need to consider possible limitations of location based service approaches. While such services may be highly beneficial, they may not necessarily reach their intended audiences, either due to limitations of coverage (for example, in rural areas (Velaga et al., 2012), or due to a lack of access to the required devices or services. The latter point may be of particular interest when considering vulnerable users, as low-income and elderly users may be least likely to have access to enabling technologies (Niehaves and Plattfaut (2014), Smith (2013), Büchi et al. (2016)). In addition, considerations related to data privacy policies (such as the forthcoming general Data Protection Regulation) and personal privacy requirements may hamper adoption of some services by members of the public.

As such services as Waze, Google Transit, and Uber, in addition to more bespoke applications developed and implemented by individual mobility service or information providers, have become more commonplace, however, investment and research into these services is also growing. While the need to consider limitations such as those indicated above will be a critical factor in service design and implementation, it is clear that location-provided mobility services will be a useful component of the overall toolkit for enabling and encouraging equitable, efficient transport.

3.4.6 Community and volunteer mobility services

Community and volunteer mobility services have spread worldwide in the last decades. In its early days, Community transport was mostly a community reaction to inadequate public transport services for specific groups in the community rather than a technical solution for low patronage areas or as a way of replacing traditional route-based public transport. Early "community transport" groups were involved in community activism, the provision of information, lobbying for improved services and making better use of existing transport resources. Since then, the sector has become heavily involved in direct service delivery although the original approaches are now being revisited via concepts such as mobility management and service-coordination (Denmark and Stevens, 2016).

Nowadays, Community transport is about providing flexible, accessible and responsive solutions to unmet local transport needs, and often represents the only means of transport for certain user groups (CTA, 2016). Using modes ranging from mopeds to minibuses, typical services include voluntary car schemes, community bus services, school transport, hospital transport, Dial-a-Ride, Wheels to Work and group hire services. Community transport benefits those who are otherwise isolated or excluded (e.g. older adults and people with disabilities), enabling them to live independently, participate in their communities and access education, employment, health and other services.

The range of services covered by the term "Community Transport" is briefly summarised in Table 3.10: Community transport services.

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Community transport services	
Type	**Description**
Community car schemes	Volunteers drive their own cars to transport individual passengers who are often unable to travel by other means due to disability, illness or lack of public transport. Some operators own vehicles (sometimes accessible) that are available on a self-drive basis.
Group transport	Community transport groups hire out vehicles – often accessible minibuses – and drivers to take the members of voluntary groups on trips. Alternatively, voluntary groups can use their own drivers.
Community Bus services	Demand-responsive or fixed-route transport services, available to the public, operating where commercial bus routes are not viable.
Shopmobility	Loan or hire of wheelchairs and mobility scooters to allow disabled travellers to get around the shops when they visit local towns.
Vehicle brokerage	Community transport organisations manage the sharing of a number of vehicles owned by several organisations in order to maximise the services that can be delivered.
Wheels to work	Scooters are loaned to geographically isolated people (often young people) to enable them to get to work, apprenticeships or training.
Door-to-door Dial-a-Ride services	These are services for individuals who can't, or find it difficult to, use or access mainstream transport services. People are usually picked up from their homes and dropped off at their destination such as the doctor or the shopping centre. Each vehicle will carry several passengers going to and from different places.

Table 3.10: Community transport services

Community transport usually receives financial support from different levels of government, provides a range of flexible transport services and continues to innovate in response to community need. In some states community transport has found a legislative place, but in others the legality of community transport operations, in its ability to charge fares, is less than clear.

One of the biggest cost differences between some community transport providers and commercial transport operators is that of labour, thanks to the fact that many community groups make significant use of volunteers. In fact, Community transport volunteers are commonly used as drivers, often for one-to-one flexible individual transport services, but they also work as booking officers, and in administration and as helpers or escorts for passengers.

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According to M. Schiefelbush (2016),

> *"Working with volunteers requires carefully looking at the circumstances of each case and the framework for using the resource. It has a strong social dimension and the procedures for professional transport management do not always suit the voluntary sector".*

It is extremely important that transport policies understand the volunteers' motivation, in order to provide a suitable framework supporting the development of concepts tailored to local needs.

One of the most interesting cases about Community transport is that one where volunteers manage and operate regular bus services. This type of service saves a lot of resources compared to PT conventional services, thanks to the "free working" of the volunteers. In this type of service, usually, besides the transport volunteer association, an important role is played by the transport provider (bus company), which runs the other scheduled bus services in the area, and by the local authority, which allow and regulate the different services. Professional license and/or qualifications are always necessary and sometimes it is difficult to fulfil all the requirements. For this reason, volunteer associations usually decide to make a sort of "co-operation agreement" with the local bus company and/or the local authority. When volunteers are use as drivers of PT, it is always necessary that the volunteers obtain a specific license (to drive the buses) and pass an additional health examination. However, when the bus is not operated as a licensed public transport service, no formal training requirements are necessary.

There are also volunteer transportation programmes specifically dedicated to older adults and people with disabilities. As described in section 2.2.4, these services are individually targeted to the needs of the rider and usually the driver (and the vehicle) stays with the rider for more than just the time of the trip (or the return trip is assured up front). In addition, these programmes allow for travel beyond the bounded area served by conventional PT lines, which is frequently necessary for accessing specialized services. The added value of the volunteer transportation programmes is the relationship that can develop between a rider and a volunteer driver. Socialization and a more personalized service such as assistance in carrying bags make this senior transportation option an attractive choice for many older adults and disabled people.

3.4.7 Active travel

Active travel: private bike and walking ("soft mobility schemes")

Active travel modes, also referred to as non-motorised modes, include cycling and walking. According to Eurobarometer (2011), a combined 20% of people in Europe cycled or walked as their primary means of transport in 2010. Walking as the primary mode is most prevalent among children and the elderly, with elderly people making one-third of their trips on foot. Cycling is more prevalent among children and young adults. The average trip length for cycling is around 3 km in most European countries, indicating the importance of cycling also for short journeys and first- and last-mile connections (European Commission, n.d.).

Active travel complements collective transport by acting as feeder modes, while collective transport complements active travel by overcoming barriers such as long distances, physical barriers and bad

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weather. Cycling in particular extends the catchment areas of public transport stops beyond walking range. Cycling and walking are becoming better integrated with public transport in many cities across Europe via:

- cycling and walking paths (protected or separated) and crosswalks that connect to public transport stations
- bike sharing schemes with docks at public transport stations
- cycling and walking wayfinding maps at public transport stations
- cycle parking at public transport stations
- benches, shelters and shady places for people to rest at stations
- car-free public spaces at/near main public transport interchanges
- the ability to bring bikes, wheelchairs, walkers, baby strollers, etc. onto buses and trains (including step-free access into the vehicle and provision of space within the vehicle)

Amongst all transport modes, cycling and walking are considered the most vulnerable modes in terms of the severity of injuries sustained and the rate of fatalities in collisions with motorised vehicles. These factors often deter certain demographics from cycling or walking, including the elderly, children and women. Active travel is often difficult for the disabled and elderly, as well as children whose parents may be concerned about their safety.

Active mobility in rural areas is challenging due to longer distances, and it is often difficult or not possible to bring bicycles onto collective transport vehicles. When bicycles are allowed on public transport, it is often only during off-peak hours and/or with extra costs involved.

Public transport operators are increasingly considering public bicycles as part of their offer and many include the cost of rental up to a certain amount as part of monthly passes/ job passes (e.g. KVB in Cologne). This trend indicates that cycling is increasingly considered an integral part of public transport which does not simply feed motorised public transport but can also be used as a (publicly and/or privately) subsidised means of getting from A to B.

At the same time, electrically assisted bicycles are becoming more popular and less expensive, bringing with them the potential to increase active mobility among less physically able users and those who need to travel longer distances. Several cities offer public electric bike sharing schemes, such as Lisbon and Madrid.

Walking and cycling are increasingly being considered in transport planning as potential solutions to manage traffic congestion (see the EU-funded FLOW project). Planning streets and public spaces with cyclists and pedestrians in mind makes urban spaces more human-scaled, liveable and safe for all vulnerable user groups. Ensuring active modes' connectivity to collective transport is essential for achieving more accessible and inclusive transport systems.

3.4.8 The concept of virtual mobility

The literature proposes different definitions of "Virtual Mobility" depending on the context and perspective. Generally, virtual mobility is about "ICT-supported activities" that realise or facilitate a task which normally requires or involves physical mobility. The definition may be specialized to specific tasks or domains; an example is teaching and learning where ICT can support activities at a distance and digitally (e.g. e-learning) or facilitate a physical activity, such as a student exchange.

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There may be situations of virtual and physical mobility being combined to maximise the advantages of both (in which case the term *blended* mobility may be used). This is an example of where the main goal of mobility is to provide access to activities, goods, information and services and not to make the journey itself.

A modern approach to sustainable mobility, especially in urbanization policies, cannot ignore this aspect. Virtual mobility, when possible, will then integrate with or replace existing actions or services that normally require physical transport. Evident examples are activities that can be carried out digitally (at least in part), such as e-learning or remote working.

Nevertheless, even in cases where services, goods or other goals can't be obtained digitally, virtual mobility can assist and ease the traveller and this situation is especially interesting for inclusive transport. Two aspects are particularly relevant: firstly, ICT allows for more efficient trips by improving the information and capacity of existing transport systems. Secondly, ICT is changing the way in which passengers use transport systems through new mobility concepts.

The first aspect has been studied for years and today's journey planners and information systems have reached a noticeable quality level which allows a considerable savings of time and improvements in terms of assistance to travellers[1]. New mobility concepts have been developed in the last years from:

- The requirement for reducing (minimising) the travel time
- The assumption that public transport is the backbone of (accessible) urban mobility and that this can be integrated into a multimodal structure with alternative modes such walking, cycling and shared vehicle use (Car Sharing).

Vehicle sharing has key relevance here. As *Barceló, Montero and Ros-Roca* point out, it is forecast that 20% of the market for global taxi services will be dominated by the growth of "carpool" variants (Ride or Trip Sharing, Carpooling Services on Demand, Uber, SideCar, Lyft, etc.) where virtual devices will be largely used to request services and obtain information. This has led to the development of "Mobility as a Service" (MaaS) systems, which combine on-demand services and Virtual Mobility assistants. Travelers can use various transport modes and their combinations to make door-to-door trips by paying for the full trip in advance and by knowing exactly what to do, where and when. Some of the "hassling" parts of physical mobility like making the right interchange, paying different tariffs etc. are then achieved virtually and in advance in a safe, convenient and efficient way[2].

It should be noted again that ICT isn't the only factor enabling these new scenarios of integrated and accessible mobility; the current paradigm shift from vehicle ownership to vehicle usage, introduced in section 3.2.7, has been facilitated by the growing awareness of the benefits obtained with the new "Multiple-Passenger, Trip-Sharing" way of conceiving collective mobility. Social changes concerning the role of the automobile and the relationships of humans to car have also moved progressively from *vehicle ownership* (tied to freedom, convenience, status, progress and lack of alternative) *vehicle usage*: a convenient and cheaper door-to-door transport mode that allows the achievement of the same goal (provision of good, use of services etc.) for which mobility is needed. Factors contributing

[1] *For more information on this aspect and how inclusive transport benefits from this, see sections 3.2.7 and 3.5*

[2] *More on ICT supporting MaaS (including planning and payment systems) can be found in section 3.5*

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to this shift include growing urbanization, virtualization, congestion, pollution, and population levels, along with an increased impetus towards social responsibility.

3.5 The influence of technologies in transport provision (SOFT (R), MEM (C), UNIABDN (C))

The development of new forms of transport services, including many solutions for inclusive mobility, wouldn't have been possible without the rapid growth of ICT in this sector. The INCLUSION project devotes an entire Project Work Package (WP2) to ICT-driven social innovations in mobility and transport. This introductory section outlines the main aspects and applications of technology in transport provision with a special focus on their current and potential impact on transport poverty, and expands upon the information provided above in Section 2.2.7.

3.5.1 Baseline of established/mature ITS-/IT-supported systems

Transport poverty is generated by Transport disadvantage, combined with Social Disadvantage (*source: Karen Lucas, Transport and social exclusion: Where are we now? Transport Studies Unit, University of Oxford*). ICT contributes to mitigate or solve some of the factors that cause transport disadvantages, especially in relation to:

- Enhancement of the quality of information
- Improvement of quality of existing transport services
- Establishment of new, alternative services able to cope with inclusive needs
- More dynamic costs and tariffs, possibility of reducing fares

Looking at the different transport schemes of Table 3.11: Relationships between defined transport services and the role of ITS, it is possible to draft schematically some key relationships between the defined transport services and the role of ITS.

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Transport service	Main Role of ITS
Conventional/Regular Transport	• Automation (service procedures, automated vehicle control and monitoring, etc.) • Service Management (service execution, monitoring, control, fleet management etc.) • Data management (data collection and transmission) • Service planning (data processing, simulations, modelling) • Ticketing and Booking (management and interactive services for the travellers) • Information provision on personal devices (mobile apps) and on-street (panels, kiosks).
Demand Responsive Transport (DRT), Flexible Transport Service (FTS), Paratransit	As for conventional/regular transport, plus (depending on the service): • Travel Dispatching • Flexible management of routing, timing of the service, and vehicle used
Ride Sharing (e.g. Car Pooling)	• Management of platform and facilities (management and matching of offerings vs requests)
Shared Mobility (e.g. Car Sharing)	• Service management for the public (subscriptions, bookings) and the operators (fleet management, monitoring, analysis, etc.)

Table 3.11: Relationships between defined transport services and the role of ITS

Digital transformation, in general, affects different scopes of transport and mobility. This introduction describes the main fields of application of automation and sensors applied to vehicles and infrastructure, and data-driven ICT solutions for users and operators.

Besides a simple introduction of the baseline of existing ITS-/IT-supported systems from the technological point of view it is worthwhile to examine, first, the aspects of impact and acceptance of digitalisation as well as the implications of the digital divide.

3.5.2 The impact of smart technologies

Digitalisation refers to the adoption of digital technologies to improve services and productivity and affects every aspect of everyday life that can be digitalized. Let's consider, for instance, the expansion of mobile services enabled by the rapid worldwide growth of smartphones, expected to be more than 5 billion by 2019 (source: https://www.statista.com). Through personal mobile devices the exact position of the traveller may be known, and information can be provided based on it and other options as well on the user's identified preferences and habits. Based on location, time and available

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data, the user can know and possibly modify the journey and even their mobility habits with dynamic mobility information and services like location-based information (available public transport, facilities, parking, transport sharing opportunities etc.) and dynamic travel planning (based on traffic).

Modern lifestyles thus create new demands by customers in terms of mobility services, and the market is rapidly following this trend. Transport digitalisation has also created new business models and cases, such as Uber, which is an example of a combination of digital transformation and low incremental costs to scale. Like similar services, Uber offer ride-sourcing and ride-sharing through a mobile app. Uber controls the booking, fare setting, tracking, payment and communications with a reduced staff while drivers use their own cars. The service brings an average time reduction in the overall total journey time estimated between 20 to 30 percent (*Hardesty, Larry. 2014. 'Ride-Sharing Could Cut Cabs' Road Time by 30 Percent'. MIT News, September 1. http://news.mit.edu/2014/rideshare-data-cut-taxi-time-0901*) and serves demand previously unmet by other services. This created significant direct and indirect increases in social utility to consumers and society through ride-sourcing as alternative to taxi services. Nevertheless, it is interesting to note that ride-sourcing users are characterised by a younger age and lower vehicle ownership. Despite the controversial status that still affects this service on legal actions and protests, this is an example of a technology-enabled service that addresses a well-defined segment of travellers.

Acceptance of automation

Another impact of ICT in mobility is the highly automated functionality applied to the automotive worlds, increasing traffic safety and supporting the development of traffic control systems. Automation is present to different degrees across transport sectors, from metro and train automatisms to car control systems to increase efficiency and safety. While in some equipment (such as trains and aircrafts) automation is well-established and proved, cars are probably the segment where most current progress lies. V2I and V2V infrastructures, artificial intelligence, cognitive systems, and more advanced sensors are becoming more and more common. Automation is the basis for a variety of driving assistance systems from no automation to full driverless cars, although full implementation and commercialization of the most advanced levels still requires considerable research and technological advancement.

Nevertheless, in both the private and public transport digital age, thanks to the increased introduction of automatisms and consequent reduction of human involvement, improved safety conditions will be increasingly common. Perceptions and awareness of advantages and efficiency are growing among passengers and it is now common and well-accepted to live with a large number of ICT-driven or -supported transport means and facilities.

The risk of digital exclusion

While new digitally-enabled possibilities exist today -including many new options in the transport sector- the problem of digital exclusion must be carefully considered. Technologies create new facilities but may also introduce -for some aspects- a new degree of inaccessibility due to digital exclusion. The concept of digital exclusion may be considered as resting on a lack of one or more of the following:

- Access to technology: Physical access to devices (such as computers, smartphones, or tablets) that are connected to the internet and allow for communication and information gathering.

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- Understanding of technology: The skills and understanding of how to use technology and technological interfaces for the purposes you desire.
- Presence of underlying infrastructure: The connective services, such as broadband or mobile data coverage, that enable use of digital devices and services.

An area or population may suffer from digital exclusion based on one or more of these factors, but understanding how they differ is key to ensuring that activities undertaken and policies developed to address them are responding to the right driver. For example, in areas that have adequate service coverage, the most beneficial action taken may be the provision of training to ensure that travellers (and others) understand how to use the enabled technology. This is a particularly critical point in transport, as digitally-enabled services will need to work across diverse areas and for heterogeneous populations.

A recent study (*The role of digital exclusion in social exclusion Chris Martin, Steven Hope, Sanah Zubairi, Ipsos MORI Scotland, September 2016*) analysed the potential relation between digital and social exclusion. Internet access, for example, is put in relation to many usual facilities, actions, and activities such as: having access to a car, flying for leisure, having a driving licence, visiting cultural events, use of council services, and participation in sports or leisure activities. The percentage of people with internet access who have or had access to these facilities and activities is much higher than those of people with no internet access. For example, 85% of those with internet access had visited some cultural event or activity in the last 12 months compared to 52% of those who do not have internet access and similar values have been registered for other cases. The relation of digital exclusion with the use of public transport and mobility in general can be seen from two different perspectives: on the one hand the use of public transport may be even higher for people with no internet access due to the need to physically undertake tasks that could be otherwise done online at home. On the other hand, the use of new transport services heavily based on ICT (e.g. booking a Demand-response service online or planning a journey efficiently) requires a minimum of technical skill, and if such technical skills are not present the services themselves may be inaccessible.

Another study from the Low incomes tax reform group (*Low incomes tax reform group – Digital Exclusion, A research report by the Low Incomes Tax Reform Group of The Chartered Institute of Taxation, April 2012*) shows that a significant proportion of the UK population is digitally excluded (see section 5) because of lack of Internet access or low levels of digital literacy, an issue that affects not only individuals but also small businesses. An interesting aspect is that digital exclusion is not only about lack of access to a computer or to the internet. Citizens should also have a sufficient level of digital literacy to be able to recognise when information is needed and to have the skill to locate, evaluate and make use of the online systems.

Being adaptive or changing the travellers' behaviour?

New services allow a strong adaptation to users' needs, which is supportive of easing the usual way of commuting and can enforce mobility habits. On the other hand, ICT-based mobility services may also support behavioural changes. Many projects and initiatives have demonstrated that travellers will accept changes to their travel habits in exchange for some reward, which is often defined as a (positive) incentive in contrast to restrictive measures. The MoveUs[3] project made an extensive study

[3] *www-moveus-project.eu*

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of this domain. If behavioural change is part of the objectives of traffic policies, the adoption of incentives and gamification strategies can be done, and this can be largely supported by ICT. Betterpoints.uk is a good example of this.

Positive incentives may be of different natures: prices, discounts, mobility credits or (facilitated) access to special services in the mobility domain. The principle adopted by MoveUs is to assign incentives whenever a 'virtuous' mobility behaviour is detected. This may include avoiding using the car, for example. Users' behaviour can be detected in several ways depending on the situation, and this is almost always supported by digital systems. An example is the detection of the transport mode through a smartphone or an in-vehicle smart box.

The link between positive incentive policies and inclusive mobility will be further investigated in the project. In fact, while existing social constraints may be "stronger" than any incentive policies, there may be situations where the assignment of incentives may be significant especially in "social" or shared transport. Let's consider, for example, assigning special incentives to carpoolers when passengers have special needs.

3.5.3 New passenger information, booking and payment services

One of the conditions that make a transport service good is high-quality, timely information, accessible with no constraints or difficulties. Smart and connected cars, networked trains, smart fleets, and automatic vehicle monitoring are fields where automatism, telematics, and sensors provide improved service quality and security, along with the background for streaming data to the public. Travellers expect to be able to connect their mobile devices and to receive accurate, real-time information about their trips. Building and maintaining a modern transport system today must be done with a digital system to convey information in parallel.

Travel time, specifically, is a key component of information that is able to influence transport mode choices in favour of public transport. Today, the journey starts well in advance of its actual execution as planning built upon vast amount of available data can readily create the conditions for full, dynamic, multi-modal journey planning, where people can choose their preferred mode(s) of transport considering what they obtain in exchange, including:

- Time savings
- Comfort
- Monetary savings
- Relaxation
- Environmental impact
- Health benefits (fitness)

In order to provide high-quality information services, the availability of Open Data, standardization and the quality of information are key factors.

Open data

Cities tend to open their data so that external providers can build services on top of them. The resulting competition creates the conditions for attractive, high-quality products. Transport for

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London (*https://tfl.gov.uk/info-for/open-data-users/*) for example freely releases their public data to allow developers to use them in their own software and services.

Citymapper (*https://citymapper.com*) on the other hand is an example of third party independent organization that collects data from different open sources and integrates it into a plethora of services for the end users. The added value service is based on the harmonization of various data sets and the offer of a unique set of services, as well as the possibility of comparing them (e.g. on process, travel time etc.) to enable the user to make a smart choice.

Data Standardisation

Interoperability of systems requires data standardisation. While standardisation bodies as well as de-jure and de-facto standards exist, the challenge is often to harmonise existing and well-established standards across different domains. Projects like e-MOTION, In-Time and Co-Cities have previously addressed this endeavour, in line with the directives for spatial infrastructures (INSPIRE). Another challenge is the definition of data standards for new forms of collective transport like those introduced for inclusive mobility. Often these new services are operated by companies or authorities without extensive co-ordination. Consequently, if transport services are complemented by digital information, booking or ticketing facilities, these are most likely coded in proprietary formats and are then unrelated to each other in terms of format: the data flows are not compatible each other and the possibilities of integration are almost nil.

The above issue of course affects (and is addressed by) Mobility as a Service (MaaS), which aims to integrate existing services into a unique, harmonized schema. The availability of high quality, standardised data is a key requirement for MaaS to exist.

Crowd-sourced data

Data coming from people is becoming more and more important. Projects like Co-Cities (*www.co-cities.eu*) have demonstrated that the quality of data can be enriched by using feedback provided by the users. Automatic collection of data can be achieved with users' smartphones used as a network of connected sensors. Google shows the most evident example of this situation, with real-time traffic information enabled by smartphone data.

In general, crowd-sourced data is becoming a key method to understand the status of services, networks etc. in real time. Pro-active feedback provision on the other hand consists of providing comments on existing services in a pro-active way. It has the advantage of being schematic and easily processed.

Pricing and payment

Digitalised, integrated, and dynamic payment is a key enabler of more flexible transport. Better data and the application of concepts like "Pay as you travel" enable new approaches to dynamic pricing and optimize the transport service. Digitalization of transport payment revolutionized the criteria for determining and applying transport tariffs. Pricing can be very dynamic and based on several variables like the day of the week, time of day, etc. It should be noted that intelligent transport pricing applies not only to public transport and MaaS initiatives but also to private transport. Dynamic parking tolls are an example of measures applied to reduce the high time spent finding a parking

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place, which has been measured as 30% of the car traffic in a congested downtown [*source: Donald Shoup – The high Cost of Free Parking*]

Digital payment is becoming more and more ubiquitous and it is expected to rise even more in coming years. Customers have gained familiarity with contactless cards and mobile payments. A complete integration of payment methods in the transport sector is not yet fully established, especially when compared to other sectors (such as retail and banking). Connecting existing infrastructure and realising an efficient data exchange between contactless devices, buses, parking spaces, shared vehicles, etc. is a condition for more advanced payment integration. In this context, often, the definition of *de-facto* standards in transport sectors come from operators largely active in transport infrastructure (and related payment systems) by extending their payment methods to other segments. An example is Telepass, an Italian company active since the 90s, for the electronic payment of highway tolls which has progressively extended the use of their payment systems and devices to parking, ferries, fuel stations and more recently to public transport and shared mobility.

Efficient digital payment systems enable the adaptation of pricing to flexible demand in new MaaS schemes. A stronger integration will ease the switch from car ownership to new mobility services where vehicles are offered based on needs. Flexible transport schemes would be at the centre of this changing process and it is likely that we can expect further developments of this with positive implications for inclusive transport. On the other hand, the accessibility of digital payments should be carefully considered. People with poor familiarity with the technology may find it difficult to pay for the flexible transport they need.

3.5.4 Customer-facing/back-office and Authority ITC/ITS

The digital enablement of customer-facing/back-office procedures in the ITS domain is important as it creates the conditions for smooth operations and high-quality services. Use of digitalised procedures to operate transport services offers:

- Simplification
- Better quality (error free operations) in data collection and service provision
- Standardisation of procedures
- Better responsiveness
- Flexibility
- Intelligence
- Smart and efficient planning

Efficient service planning aims at satisfying current and future demand and bringing new ideas and service models to more advanced stages of evaluation and validation, thus easing the introduction of improved features and aspects in the overall offering.

ITS bring automation and efficient management of transport services and operations, data composition and delivery and accurate planning. Virtual models of transport services can be created and used to make predictions and simulations which would have been impossible to achieve in real conditions. The accuracy of the models allows us to replicate and understand situations and events

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that occur in the real world and enable more accurate planning of better and safer services. The potential benefits are also significant for inclusive transport and mobility in terms of:

- Failure prevention
- Suitability of the service for certain user categories
- Better planning e.g. in terms of schedule, vehicles
- Evaluation of new concepts and transport schemes

4 Part B – Identification of challenges and needs of different user segments and area types (MEM, SOFT, RUPPRECHT, MOSAIC, UNIABDN)

4.1 The challenges in providing collective transport services

The mobility paradigm is transforming rapidly. The decrease of "commuting" trips and the increase of "erratic/dispersed" mobility demand, the emerging available mobility schemes and services, the new transport providers based on large IT platforms (Transport Network Company-TNC) and the changing of citizens' perspectives (which are slowly moving from the idea of "having my own transportation" to "use various modes", including sharing, based on needs and preferences) are just some examples of the new emerging trends that are spreading worldwide (see section 2.2 for details). "Usability of the services" concept is the driver of new lifestyles in Europe, and social media are strongly pushing "Virtual mobility" (see section 2.4.7 for details) that is included in the evolving concept and initiatives indicated as MaaS- "Mobility as a Service". In this context, prioritised areas face a wider range of mobility challenges. For example, in many rural areas across Europe, low population density, variable demand over time (e.g. day hours, day by day), and competition from the private car make it increasingly difficult to operate "conventional" (fixed route and fixed timetable) public transport services that are commercially viable for some connections but not for others/all the conditions. The capacity for public subsidy to maintain such services is being severely challenged at a time of highly constrained public funding (International Transport Forum OECD, 2015), and limitations in transport infrastructure (often occurring in prioritised areas) and services can have significant social and economic consequences for communities in terms of reducing travel horizons and hindering access to opportunities such as employment, education, health and social activities. Some disadvantaged user groups such as elderly people who no longer have a driving licence or families with children who have an insufficient number of cars (or no car) to satisfy their own mobility requirements, can become socially excluded if an accessible transport service is not provided. In this changing environment, how is it possible to provide transport services that respond effectively to the different users' needs?

In order to answer these emerging issues, the EU framework (European Commission, 2011) is clearly moving towards an integrated transport network that will increase sustainable mobility, remove major barriers in key areas and fuel growth, employment and social inclusion. In this scenario, public transport services are becoming more and more important: in fact, while it is sometimes assumed that public transportation is only essential for large urban areas with relevant mobility demand and high traffic congestion levels, public transportation can also play an important role in rural/remote areas, semi-rural and suburban areas, deprived areas etc. (for

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examples of prioritised areas, see section 2.1 for details). Although public transport still serves a small percentage of total rural travel, the mobility opportunities offered by PT are particularly valuable for disadvantaged user groups (APTA, 2017). In order to increase mobility opportunities in prioritised areas and to cope with evolving needs and variability of mobility demand, PT must differentiate its offer in terms of service schemes/options (e.g Demand Responsive, ride sharing, services targeted for specific user groups, etc.), customize each of them to the local needs and specific purpose/target clients, and operate them in a co-ordinated way as last-mile/feeder of the "conventional" services (serving main axis/connections). Although public and private sector stakeholders have to work together to address challenges related to issues such as regulation, insurance, business models and equity (Shared-Use Mobility Center, 2015), shared mobility services can really improve the accessibility of prioritised areas; thus, they need to be integrated in to the whole mobility offer. It might be that Public Administrations and PT/Mobility Authorities/Agencies take the lead in exploring the modalities of co-ordination/co-operation and playing a key role in defining the framework and related solutions. From the perspective of demand, a mobility offer restructured as indicated above allows us to engage potential customers who are available to use PT on an occasional basis by combining this choice with other possibilities; in a short time, the frequency of use of PT can be increased.

As a conclusion, a possible answer to the mobility challenges facing prioritised areas is an integrated (in terms of transport modes and services) transport supply to be developed through:

- Rationalisation of the offered conventional transport services supply in respect to the actual needs of the users, focusing on main routes and peak-hour journeys, improving travel times to connect main destinations, etc.;
- Enhancement of co-ordination among different operators and improvement of multi-modal options;
- Collaboration among public and private operators in order to offer complementary services (Flexible Transport Services, Demand Responsive Transport, sharing and active modes…) in the low demand period or to serve low demand areas;
- Implementation of "feeder services" (FTS, DRT, sharing and active modes…) in relation to the main routes or main connections (e.g. complementary feeder services to the main routes in the sub-urban areas, feeder services to reach Municipalities/Small towns from accessible/remote rural areas);
- Implementation of dedicated services for target user groups as part of the FTS;
- Supply of users' information system related to the different transport services through centralised platforms and common channels, in order to set up common platforms that enable data and information on transport's services to be shared between users;
- Increase the inter-operability between different transport modes/transport operators;
- Increase usage of flexible tariffs (pay-per-use) and of the methods of payment, with particular attention to the needs of "flexible users" to verify the feasibility of MaaS approaches for the prioritised areas.

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This section will illustrate the main issues and challenges in providing such an integrated transport supply.

4.1.1 Needs related to collective transport service provision in prioritised areas

Any analysis concerning the provision of transport services should start with the definition of the user categories with respect to the area to be served. Normally when the term "user" is employed, consideration is only given to the "end-user" of the service - in other words, the person who is already a service customer/user. In fact, there are many other categories of users in the sense of actors who play a role in transport service provision. The concept of user groupings makes clear that these different actors exist, and that they have validity within the design and assessment processes (Ambrosino et al., 2004).

Based on research of the different stakeholders who are responsible for transport services in European countries, four principal Actors may be determined (**Errore. L'origine riferimento non è stata trovata.**).

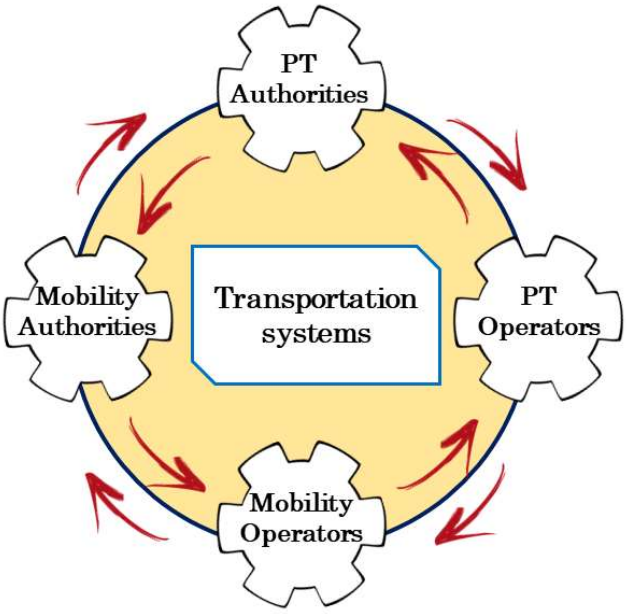

Figure 4.1: Actors involved in the transport system

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Actor/User group	Role	Characteristics
Public Transport (PT) Authorities	Definition of needs in relation to the conventional public transport services, service contracting, monitoring of transport performances, management of contract obligations	They are responsible for the regulation (and in some cases for the provision) of transport services in the target area. These authorities can act as Agencies dedicated to the management of the transport or as local administration departments. There can be more than one in relation to the different services they are involved in.
Mobility Authorities	Definition of needs in relation to mobility services other than PT (bike sharing, car sharing, etc.)	There can be more than one with responsibilities on different services on the same area. They can be Local Authorities or dedicated Agencies.
PT operators	Operation of the transport services	They can be private or public. Their size (in terms of fleet) can vary a lot.
Mobility operators	Management of vehicles/ride sharing mobility services	Usually are private companies; sometimes are community or voluntary organisations.

Table 4.1: User groupings and related main characteristics

Each of the identified Stakeholders has a range of user needs; these needs are different because diverse actors have different objectives; for example, the PT authorities want to reduce the funding of PT to improve its commercial strength, whereas the PT Operators want technological investments and their operational costs to be considered in the service contract (e.g. as bonus conditions).

The main needs and concerns related to the Stakeholders identified are briefly listed below. It has to be noticed that at Authority level (PT Authorities and Mobility Authorities) the needs are more or less the same.

- **Authority level**
    - To co-ordinate responsibilities among the different authorities/operators involved in mobility/PT planning/management;
    - To improve the "customer orientation" planning of transport and mobility services;
    - To encourage different operators to collaborate or join up;
    - To guarantee the inter-operability in respect to information and service access;

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- To define shared procedures and tools in order to collect the service data (from different operators) related to the service performance and in order to validate and control the service;
- In addition, to obtain performance indicators from small Operators;
- To define an Operator that acts as leader to collect performance indicators from the others (serving the same area) and to act as intermediary within the Authority;
- To adapt the regulation and to define suitable co-operation schemes to enable co-operation between PT operators with private operators.

- **PT operators**
  - To optimise management costs by avoiding crowded vehicles during peak-hours and empty buses/trains in the low demand period;
  - To find solutions to support the integration of the service supply (e.g. Shared Mobility Agencies (Ambrosino et al., 2016)) in order to optimise the resources in terms of vehicles and services;
  - To define bonus conditions in the service contract for increased quality (i.e. compliance with the planned timetable, number of trips not carried out, etc.) and specific incentives for the provision of flexible services (i.e. availability of buses to operate DRT services despite the number of travel requests received for the covered day period);
  - To define performance indicators to monitor flexible services;
  - To implement suitable co-operation schemes to allow the co-operation between PT operators with private mobility operators;
  - To obtain resources for acquiring support IT services like the digitalisation of information and data collection related to service operation (specific for small PT operators);
  - To collaborate with other actors involved in the transport supply chain in order to integrate the service supply and to share management costs with 'bigger' operators (specific for small PT operators);
  - To optimise the service operation time/area complying with available resources (vehicles, staff, finances) and demand characteristics.
- **Mobility operators**
  - Identify strategies to enter the market of prioritised areas where the scarce number of users makes it difficult to operate with services like bike-sharing or car-sharing (specific for private operators);

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- Adaptation of business model to co-operate with PT operators (specific for private PT operators);
- *(Relevant in some EU countries)* To adapt transport regulation to allow the effective integration of their services to the whole mobility offer (specific for community and volunteer organisations).

4.1.2 DRT in prioritised areas: opportunities and challenges

In prioritised areas, and especially in rural or peripheral areas where issues like low demand and dispersed origin/destination points are common, Demand Responsive Transport Services (DRT) can be a valuable and efficient solution. We are moving very quickly from public and private transport being separate services, to a more Integrated Multi-Modal Mobility Network, due to changing demographics, preferences, and technology (Frost and Sullivan, 2015). In this future scenario, DRT and Paratransit services can improve the accessibility and inclusivity of people living in prioritised areas, by integrating with conventional PT (see above). In fact, there are several factors (e.g. increasing numbers of elderly people who will be able to travel but no longer to drive, an increasing number of younger people who don't look at the private car as "mandatory" ownership, increasing pressures on the global economy, etc.) pushing an increased role for DRT and flexible transport-type modes, combined with car, bus and taxi (Enoch, 2015). Nevertheless, Paratransit system and DRT services are proceeding at a slow rate, initially due to cost and technology issues, but now due to regulatory and institutional barriers (Enoch and Potter, 2016). This is the reason why PT and Mobility Authorities should look forward to a new regulation system that allows a strong enforcement of the role of DRT services.

The Public sector and Private Mobility operators, recognising that technology and business models from the shared mobility industry can help drive down costs, increase service availability and improve traveller experience, are eager to collaborate to improve Paratransit service (TCRP, 2016). With a new generation of tools available and a growing interest in DRT from both the transportation and business perspective, the question is "how do we unlock the potential of DRT?". This requires five interlocking dimensions:

a) Develop new service concepts to meet evolving needs;

b) Identify clearly the markets these will serve and the transportation function for each;

c) Identify, develop and deploy the appropriate technical solutions to deliver the services;

d) Develop the business case for the foreground and background services;

e) Establish the appropriate organisational structure and relationships to provide the framework for delivering the transport services and managing the customer interface.

How these are achieved will vary from location to location, but failure on any of these dimensions will undermine the potential and stability of a DRT project (FAMS, 2002).

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The main needs and concerns consistently expressed by authorities and operators across DRT sites are briefly summarised in the table below (Ambrosino et al., 2004).

Authorities	Operators
NEEDS	
▪ Define a specific and focused DRT/FTS regulatory framework with clear and defined indications regarding subsidies, payment factors, responsibilities, etc. ▪ Improve tender/procurement process of conventional PT services including FTS and TDC/Agency management and related specific indicators ▪ Develop targeted promotion campaigns and marketing initiatives for raising users' awareness ▪ Achieve the maximum degree of accessibility, from the spatial and temporal point of view, for the widest number of users possible	▪ Operate viable services in a sustainable way ▪ Maximise patronage ▪ Engage more potential users of PT ▪ Guarantee cost efficiencies in service provision ▪ Maximise occupancy and minimise dead running ▪ Identify suitable/improved technical support systems according to service scheme to be operated ▪ Integration with other modes/routes ▪ Ability to expand coverage area in a sustainable way
CONCERNS	
▪ Break down the scepticism of many policymakers frequently considering FTS as a "last resort" and "secondary" service and insufficient political commitment ▪ How to establish and enhance a strong and structured collaboration among the different actors involved in PT services provision and organisation?	▪ How to achieve a quick start-up period for new services? ▪ Which rules to accept non-booked passengers? ▪ How to face operation costs for an effective/efficient Travel Dispatch Centre?

Table 4.2: Needs and concerns related to transport authorities and operators

4.1.3 Difficulties in developing suitable customer-centred services

In the twenty-first century, it has become more and more important to offer services that are personalised to meet the requirements of different customers, in order to allow people to maintain their lifestyles.

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In order to offer customer-oriented services, an important role is that provided by smart technologies, such as personal mobile devices, smartphones and their related mobile applications. These have deeply changed the way citizens are becoming used to accessing services in general (and Public Transport/mobility, in particular). For example, real-time passenger information (RTPI), booking, payment, customer care services, etc. are evolving towards "real-time", "always connected", "on-demand" or "customised" approaches. These are, on the whole, more targeted to provide customised information to individual expectations and to be available at any stage of the journey.

Furthermore, over the last twenty years, the focus of the drive for sustainable mobility has been in cities. The increasing success of innovations for urban mobility have tended to shadow the lack of progress in the regions surrounding the cities – from outer suburban areas to satellite towns and rural areas.

MaaS (Mobility as a Service) can be broadly defined as the transition from a dominant car-ownership model of mobility, to one of paying for one's mobility 'on account' using more sustainable modes of transport as an alternative to private car use (Hietanen, 2014). With MaaS, individual transport needs (usually satisfied by owning a car), are met instead by a range of services that include car leasing, car clubs, carpooling, community transport, and cycle and taxi services in combination with 'traditional' public transport. In general, MaaS has been centred on urban/suburban areas. The requirements for delivering MaaS in a rural setting, where both the demand and the available mobility resources are lower remain a relatively unexplored area. The experience in the USA has been that TNCs (Transportation Network Companies) do not serve areas of lower population and demand ("redlining"). Nevertheless, even if these mobility services do not extend to rural areas, their service model and technological approaches might be transferable. Furthermore, the current state of progress of MaaS initiatives around Europe highlight the following limitations: lack of integration between the different transport providers (currently there are several Public Transport operators that may have previously viewed providers of new mobility services as rivals (Canales et al., N.D.)); a lack of co-operation schemes between actors; difficulties in definition of dedicated commercial agreements (which could also change the business model of the two parts – PT operator and sharing provider); the need to solve liability issues; and the reluctant role of PT authorities/stakeholders to take the leadership of a MaaS initiative. Moreover, the main gaps that are slowing the development of MaaS in rural areas are the poor digitalisation level of data to be integrated by MaaS provider, the budget constraints of small- to medium-sized operators (who are unable to invest in technology), the presence of low demand and low performance of communication networks and the limited investment in infrastructure.

Taking into account these considerations, in order to answer properly to the end-user needs in prioritised areas, transport authorities/operators should try to follow these strands of activities:

- Understand the potential and the role of innovative shared mobility services in relation to the main characteristics of the target area;
- Identify and select the services scheme/solution that properly address the specific prioritised area characteristics and the related user needs, in order to customise the transport service supply in an integrated way;
- Identify validated technology solutions that allow the integration of data;

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- Develop a cost model that recognises the extra costs generated by unconventional services (e.g. the availability of the fleet in DRT services);
- *(For PT and Mobility Authorities)* Amend the current Public Transport Regulations in order to encourage co-operation among PT operators and social entrepreneurs.

4.1.4 Understanding the emerging needs of disadvantaged user groups

Understanding the nature and evolution of mobility needs for diverse target user groups is one of the key aspects to consider when talking about the provision of transport services. The User Needs Analysis is essential both when there is the intention to implement a new transport service/solution and when there is the intention to improve an existing transport service, because this phase allows us to understand the different users and to use this knowledge to design a system to meet these needs. The outputs of this phase should identify the key markets, the services and features that they need, and requirements for communication and information after services are implemented. In addition, the User Needs work provides an excellent opportunity for consensus forming and awareness raising within the host community (Ambrosino et al., 2004).

Public and Private Transport operators always deal with travel needs of citizens, their attitude towards travel, their personal behaviours and their willingness to change them. Satisfying mobility needs world-wide is a complex issue. The aim of this section is to clarify how Transport Authorities/Operators can find the answer to questions such these: what are people's mobility needs? Where do they want to travel? How is it possible to meet the ever-changing demographic demands, such as an increasingly elderly population? What are the needs of people with disabilities? How much are people willing to pay?

The following considerations emerge mostly from the result of CIPTEC, a European Project funded under the Horizon2020 Programme where an integrated approach has been developed that draws on the best ideas derived from marketing (i.e. customer orientation, marketing research, consumer intelligence), consumer behaviour (i.e. advanced motivational research, behavioural experimentation), innovation (i.e. crowd sourcing, collective intelligence, co-creation and co-design of new ideas, fusion of business concepts with social innovation), evaluation (i.e. socioeconomic, technological and ethical) and co-exploitation within a wider than usual stakeholder platform attacking the challenges that hinder the public transport "environment" transition and re-orientation towards increasing PT market shares.

In Public Transport, service needs are usually identified based on stakeholders' perspectives/expert opinion and on survey analysis of customers and potential users. Recently, these approaches have been partially overcome or integrated due to the evolving trends in society, technology development, the ways in which services are accessed and used on a daily basis, and the development of new "interactive" user-centric involvement strategies/tools.

First of all, it has to be noticed that the classification of different user groups and the identification of the disadvantaged groups is evolving toward a new approach where aspects such as: personality; lifestyle; travelling attitudes; and actual behaviour within the use of Public Transport will be used for

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segmentation, rather than the traditional categories used in the past such as demographic, geographical, social, etc.

Secondly, the identification and engagement of the disadvantaged user groups in service planning/improving is becoming more apparent. Currently this involvement is also evolving towards more innovative, "interactive" approaches resulting from the social sciences and the adoption of crowdsourcing tools: in fact, the ways to make the user groups interact with Public Transport Stakeholders and experts and contribute to the co-creation of new ideas/solutions for Public Transport can vary; taking advantage of the various examples provided by social science (Brainstorming sessions, World Cafè, Lego Serious Play, Conceptual Mapping, Problem Tree, storytelling, case studies etc..) and from crowdsourcing campaigns.

Within CIPTEC, crowdsourcing campaigns and co-creation workshops have been successfully implemented and have achieved their initial objectives: in fact, the implementation of these activities demonstrated that such collective intelligence processes can significantly increase Public Transport's ability to innovate. The Public Transport Authorities that participated in the CIPTEC consortium found the application of the process in their contexts to be very interesting and beneficial for their organisations, in particular for their new product/service development processes.

Overall, these activities indicate the importance of introducing user-centred design models for the field of Public Transport, as well as for the establishment of mechanisms that stimulate the dialogue between Public Transport organisations and users (current and prospective).

Finally, it has to be noticed that while it is possible that data crowdsourced from passengers may be utilised for improvements in information provision, thus demonstrating benefits in passenger/operator communication, it is still less understood how to effectively use crowdsourced data to support or enhance operator capacity improvements. Such uses would include schedule adherence feedback to operators, enhanced scheduling, service design, and operations from analysis of historic data, understanding of passenger journeys through collection of boarding and alighting data, etc.

4.1.5 The opportunity of digitalisation for prioritised areas

Digital disruption is profoundly changing the way we live, work and relate to one another. Digitalization can support the development of a more sustainable society in many ways, for example by reinforcing mobility system and increasing accessibility of vulnerable groups to public and private transport. In the table below, different opportunities (Davidsson et al., 2016) are listed in three main areas: Environmental, Social and Economical sustainability.

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Areas	Opportunities	
Environmental sustainability	To **reduce direct emissions** from public transport	By optimizing routes, time-tables, style of driving, vehicles sizes…
	To **reduce in-direct emissions** (from the non-public transport systems)	
	To **improve land use**	By reducing the space dedicated for car parking
Social Sustainability	To **improve social equity** and sustainable living in prioritized areas	By increasing accessibility of vulnerable groups to public transport
	To **reinforce** the feeling of **social inclusion** and **life satisfaction**,	By increasing the coverage of public transport services.
	To **increase the access to different** activities	
	To improve **personal safety**	By increasing public transport safety
Economical sustainability	**To save money** by the Public Transport Providers	By optimizing the use of resources in public transport
	To **minimize the travel time**	By reducing the waiting time for transport services and optimizing routes

Table 4.3: Opportunities for digitalisation for prioritised areas

Some recent developments in Information Technology such as open data, big data, sensor technology, artificial intelligence, social media and platforms or crowdsourcing can be seen as powerful enablers of multi-modal solutions (Athanasopoulou et al., 2016) in which cars ownership is no longer central but the core are new mobility business strategies from selling a product to providing a customer experience-centric value proposition services.

The impact of these digital transformations will spread far beyond the business space, dramatically changing how we live, delivering important benefits like enhanced efficiencies, reduced costs, greater collaborations or more innovation for businesses, consumers, society and the environment (Accenture, 2017).

Especially, these digital opportunities will be meaningful in prioritized areas where transport accessibility can be improved, contributing towards a sustainable society. Digitalisation will be fundamental for these vulnerable groups to get better solutions for both transport operators, strategic transport planners, as well as, for the travelers. Using connected platforms and networks, organizations will have a deeper understanding of the travelers' specific needs (see Point 3.1.4) and will be able to customise mobility services.

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Finally, besides the great opportunities of digitalisation, there are also some challenges that need to be addressed, both technical, such as data collection issues, interoperability, scalability and information security, and non-technical, such as business models, usability, privacy issues and deployment.

4.1.6 Increasing differentiation among urban, peri-urban and non-urban areas.

As indicated in section 2.1, the geography of an area has myriad impacts upon appropriate transport service provision. In particular, population densities, patterns of mobility, and activity generators differ between urban, peri-urban, and rural areas, thus impacting upon the suitability of different models of transport services. For example, in urban areas with high population densities and relatively consistent activity generators, the market for fixed-route public transport (whether road- or rail-based) will generally remain constant and thus will have a higher likelihood of being cost-effective. In remote rural areas with low population densities, sparse settlements, and either irregular or constant but constrained activity generation, flexible route or demand-responsive services may be more appropriate. In this section we explore how geographic characteristics associated with degrees of urbanity or rurality may impact upon transport service decision-making.

Transport provision in densely populated urban areas may be broadly considered as characterised by generality. While specific corridors or areas of an urban conurbation may be more or less suited to specific types of transport service based on population socio-demographics (for example, in areas that contain housing for elderly or student populations) or particular activity generators (for example, sports venues, commercial sectors, or industrial areas), the urban area taken as a whole likely requires service provision to address a range of needs across a fairly dense and heterogeneous population. Characteristics of urban areas, such as built environment density and a greater incidence of mixed housing and commercial activities, may lend themselves more readily to fixed route services, including both rail and bus offerings. According to Hensher (2008), "In establishing a role for public transport, it should be enshrined in the motto of delivering 'frequency, connectivity and visibility' that is value for money as defined in terms of net social benefit per dollar outlaid." Such a statement is further underlined in the report *Assessing the benefits of public transport,* produced by UITP, which states, "The affordable access provided by public transport to opportunities is fundamental in the drive to creating a more inclusive society. No other modes can come close to the ability of public transport to safely and efficiently provide urban mobility to large numbers of people. Improving public transport systems, therefore, is also the only way in which the future challenges of urban growth and mobility, sustainable economic development and climate change can be successfully tackled." Such considerations align well with the need to provide comprehensive transport coverage in urban areas, supported by adequate infrastructure for walking and cycling.

It should be noted, however, that even in urban areas, not all service types will be appropriate for each area of coverage. Some areas, such as entertainment districts, may require transport services during late hours, or provide geographic coverage for employee transport. Others, such as medical districts or hospitals, may additionally require service provision that meets the needs of individuals with mobility challenges. Overall, the key need is to provide a range of services, tailored to the specific area of requirement, but accounting for the spatial and temporal coverage of need.

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Peri-urban (or suburban) areas may require some of the same types of services, but potentially aligned to less dense networks and with more constrained hours of overall need. Alignments between urban and peri-urban areas are particularly important to consider here, as travel patterns often reflect the employment opportunities and access to services offered in urban areas. Generally, the density of demand in suburban or peri-urban areas is lower than that in urban areas, which may impact upon the cost-effectiveness of fixed route public transport services; in addition, networks of supporting infrastructure (such as foot- or cycle-paths) may be lacking or less contiguous, which may discourage public transport use. In these areas, services dedicated to specific corridors (such as those linking residential areas to railway stations or providing commuter services into the urban core) may represent the only fixed-route services that provide cost-effective and appropriate services. Supporting models of service, such as demand-responsive or flexible routes, ride-sharing, or other paratransit options, may be established to cater for infrequent trips or to provide support for persons with mobility challenges, non-car owners, or those who are otherwise transport disadvantaged. Some authors have suggested models of personalised public transport, with Vishwanath et al. (2014) suggesting that, "PPTS is aimed at providing coverage in both urban and suburban regions." They suggest that by providing services, such as car sharing, in a more accessible fashion in suburban areas public transport may be viewed as a more attractive option.

Rural areas may be even more difficult to serve, as low population densities, dispersed residences and irregular travel patterns may make fixed-route services difficult to argue for on a cost-benefit basis. Velaga et al. (2012) argue that, "…a basic problem with rural transport is the lack of opportunities available to access a necessary range of basic service outlets and amenities located in distant centers." In such circumstances, they suggest that flexible public transport services may be a useful option to consider for providing necessary coverage at a reasonable cost, following from Mulley and Nelson (2009). The challenges evident in providing adequate public transport in rural areas was highlighted in a report produced by the Northern Ireland Assembly, which found that public transport in rural areas of Northern Ireland were inadequate to effectively serve the needs of the population, citing lack of supportive policy and funding, lack of co-ordination across services, and a failure to effectively link to necessary services. Such a finding is reflective of models that are most appropriate for denser urban areas, but that fail to acknowledge the needs of more sparsely populated rural areas. As many rural areas begin to face challenges associated with ageing populations, less well developed technological infrastructure, and declining economies, reviewing emerging models of service provision will be necessary for ensuring adequate coverage and thus access for all populations.

4.2 Identification of gaps in transport infrastructure and service provision (RUPPRECHT (R), MEM (C))

This section focuses on identifying the gaps in transport infrastructure and service provision that are commonly found in transport systems in general and which result in a failure to meet the needs of vulnerable user groups. Where relevant, differences in the prevalence of these gaps in specific area types across Europe are identified (e.g. east vs. west, urban vs. rural, etc.), as well as their effects on particular vulnerable user groups.

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Transport infrastructure includes both physical infrastructure and virtual infrastructure. These elements create the structure of the transport system. Transport systems with gaps and insufficiencies in transport infrastructure mainly result in physical barriers for users' mobility within specific parts or the entire transport system.

Transport services, on the other hand, support the comfort and seamlessness of users' journeys within the transport system. They include the provision of information and the various aspects contributing to the overall level of service provided to users (e.g. frequency, reliability, etc.). These services mainly influence users' level of understanding, trust and satisfaction with either parts or all of the transport system.

On the users' side, psychology also plays a part. Sometimes people's perception of a transport service can become a real barrier to travel even when the perception is at odds with the reality of the situation. For example, a poorly lit rail station or bus stop may be a barrier to travel particularly for women and lone travellers even when no crime has occurred in that location. There is a clear need to tackle the perceived safety and security issues of travellers as well as the actual situation. If a location or service is perceived to be unsafe, then the actual barriers which create this feeling need to be tackled if passengers are to trust the location or service and hence change their behaviour to use it. Passenger perception is complicated to unravel and some measures to reduce the perceived barriers to travel have been unravelled through research and is discussed in the section on stations (Mark van Hagen research NS_.
https://research.utwente.nl/en/publications/waiting-experience-at-train-stations

Gaps in transport infrastructure, services and in some cases perceived gaps have a direct impact on users' transport behaviour and mobility opportunities in the affected area(s).

3.2.1 Gaps in transport infrastructure

Vehicles

Vehicle design plays an important role in the accessibility of transport systems. Users of all capabilities must be able to enter, ride/ move around within and exit the vehicle comfortably and safely.

There are many design aspects which help people to board and alight from a vehicle. Without these measures some people with disabilities, the elderly and those with young children are either excluded from accessing the vehicle or they encounter a lot of difficulties which can deter them from travelling.

Level access between tram and the platform enables easy access for all passengers and is especially helpful to wheelchair users and those with young children in strollers.

Low floor buses allow level access for wheelchairs and buggies and also help people with some other mobility issues. There is often a compromise on smoothness of ride on low floor buses by nature of the chassis design and this can present disadvantages to some disabilities which prefer to avoid vibration such as arthritis and balance disabilities.

Another bus design is the kneeling bus which gives passengers the option of asking the driver to lower the bus. This solution is particularly popular with the elderly.

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When passengers wish to use vehicles with these features to aid getting on and off, it can be a problem if there is variation throughout the fleet which creates uncertainty. Passengers need to know that the next bus or other vehicle will be accessible to them. This is particularly relevant in rural or remote areas with an infrequent service or at times of inclement cold or wet weather.

Another problem in the UK is that bus deregulation since the 1980s has meant that many areas away from the main cities have to rely on a bus service run to make a profit which often uses old vehicles with none of the accessibility features that have become the norm in the major cities. There is a very real disparity between services in metropolitan areas with funding for passenger services and the services in rural areas and small towns.

Driver behaviour can impact on the value of the vehicle design. For example, it does not matter how good the vehicle design is if passengers with a disability cannot trust the driver to wait until the passenger is sat down before driving off. Some transport operators have mitigated against this through driver training and through provision of badges e.g. First Bus badge template where passengers write their request on the badge e.g. please let me sit down before driving off. https://www.firstgroup.com/uploads/node_images/Safe_Journey_Card.pdf

Once on the vehicle, the provision of good information regarding the next stop and route in audio and visual form can be very reassuring and enable a passenger to be ready at the correct time to get off. Many services across Europe provide constant reassurance of the next stop e.g. Reading Buses UK, Paris Metro, Germany most RE and IC trains.

On longer vehicles (trams and trains) where the passenger is remote from the driver this information is more necessary. A good quality of lighting is also beneficial to everyone to help with moving around the vehicle and with a general feeling of safety. There has been some debate concerning female only carriages. These can work well if there is some form of policing by personnel to enforce this. Otherwise it could be seen as a way of advertising where woman are traveling alone. This segregation may be more beneficial when used for car share where everyone in the vehicle including the driver is female rather than conventional public transport. https://www.suzylamplugh.org/Pages/FAQs/Category/personal-safety

Toilet facilities on longer journeys are considered necessary to many people and especially the disabled, elderly and those with young children. A lack of toilets can be a very real barrier against travel. More than one toilet is deemed necessary even on small trains to help ensure that there is always a working toilet available.

The internal vehicle design and layout of spaces for wheelchairs and buggies with or without tip up seats can impact on the passenger. Wheel chair passengers and people with young children in buggies need to have some trust that a space will be available for a wheelchair/buggy. A design incorporating several spaces is therefore helpful. RTPI on the availability of that space before the vehicle approaches can be reassuring. Also the facility to notify the driver via an App that there is someone with a disability waiting at the stop can be reassuring and thus break down the barrier of uncertainty regarding what help may be available.

A more ambitious form of information for the visually impaired to be able to negotiate a journey from their home via bus and train is being piloted in Reading UK using a sound scape https://news.microsoft.com/en-gb/2015/11/25/cities-unlocked-a-voyage-of-discovery/

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Other passenger needs can be met through badges which give the passenger confidence to travel by helping to remove uncertainties e.g. TfL's 'Please give me a seat' for people with invisible disabilities and 'baby on board' badge for pregnant women have proved popular in London buses and underground. http://metro.co.uk/2016/08/30/tfl-is-introducing-new-badges-and-cards-for-people-with-disabilities-and-invisible-illnesses-6099377/

In summary, the factors which play a role in vehicle accessibility include:

Potential gaps in vehicle design	Most severely affected user group(s)
Access into the vehicle (e.g. level platforms, low-floor vehicles, kneeling buses)	Elderly, disabled, people with baby strollers
Accessibility while on the vehicle (e.g. provision of space, audio/visual/tactile information)	Elderly, disabled, people with baby strollers
Safety (e.g. lighting, security cameras, female only cars)	Elderly, women, children
Facilities (e.g. toilet) Linking driver behaviour to facilitate easy use of accessible design	Elderly, disabled, children
Probability of getting a seat (particularly on low frequency services), badges to help increase awareness of a passenger's needs	Disabled, Elderly, pregnant women

Table 4.4: Factors which affect vehicle accessibility

Stations

Passengers can be deterred from using rail stations due to inaccessible parking for bicycles, shared and private vehicles. More needy users (disabled and those with young children) should have designated parking spaces as close as possible to the station entrance. Many rail stations in UK particularly in small towns and rural areas (e.g. Salisbury, Wilts) are situated some distance from connecting public transport and this can be a huge barrier particularly to those encumbered with luggage and young children.

Presence of seating and shelter at stations

Elderly passengers, those with disabilities and those with young children can be deterred from using stations if there is nowhere convenient to sit and wait. Seating should be provided along the route taken by these people to include seating between the station and other modes, particularly designated parking for the disabled. Without this seating along the route, the parking itself may be a barrier since there is nowhere to rest between the parking and the station. Sheltered seating indoors or sheltered from prevailing winds and inclement weather should be provided on the station. The materials also need to be thought about carefully. For example, metal seats may be easy to maintain and vandal proof but they can be most uncomfortable to someone disabled when the temperatures are very cold. Such discomfort can deter future travel.

A feature to help one disability can be a barrier to another disability. For example, escalators help many people with disabilities and also those encumbered with luggage but they can be a significant barrier to people with balance or walking disorders or visual impairment. A combination of measures

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is therefore the ideal. TfL provides a journey planning tool on its website where passengers can seek the best stations or route according to the barrier they wish to avoid e.g. escalator, steps, lift etc. There is even a map to help people with claustrophobia to avoid tunnels. https://tfl.gov.uk/maps/track/tube

Audio/visual/tactile information and guidance

The elderly and some people with disabilities can have problems processing information which deters them from travelling in overstimulating environments. Clear information which is not distracted too much by adjacent advertisements and other stimuli can help break down this barrier. The prevalence of advertisements adjacent to signage can be a barrier to travel for these groups, whilst many stations and interchanges are increasing advertising to increase revenue. Research by Dutch Railways suggests keeping this overstimulation to a minimum in circulating areas and instead focusing the stimulation in waiting areas.
https://research.utwente.nl/en/publications/waiting-experience-at-train-stations

More specific information for the visually impaired is being developed in Vienna to provide information at every tram stop https://www.euractiv.com/section/public-transport-accessibility/opinion/vienna-shows-local-solutions-can-improve-public-transport-accessibility/

Clear signage using icons can also be helpful as this reduces barriers of language and of processing. E.g. Swedish underground network changing signing to icons to help everyone identify the meaning quickly, including those who do not speak Swedish (migrants, tourists). https://www.slowtravelstockholm.com/arts-culture/going-underground-stockholm-subway-art/

Actual and perceived safety or lack of safety and security can deter travel particularly for the elderly, visually impaired, women and lone travellers. All areas of passenger use should be well lit to enable people to move around easily and to feel safe.

Enclosed and secluded station environments can create a feeling of vulnerability and isolation and deter travel particularly by women and lone travellers. Security cameras can be of some help but the most effective and reassuring environment is one that utilises natural surveillance through careful use of vegetation to avoid screening, removal of unnecessary high walls, tight corners and encouraging land uses which increase human activity and reduce feeling of vulnerability e.g. shops, housing.

Difficulties accessing on-line ticketing can be a barrier for many groups. Ticket machines at stations enable those without access to a computer or with little computer literacy to obtain tickets for travel. For some people with processing or anxiety problems, a ticket in the hand can be very reassuring.

Location of facilities at stations can deter or encourage travel by the nature of the setting and atmosphere that is created. To enable easy circulation by people with disabilities, the elderly and those with children the station the circulation areas should not be too busy and hence need to have adequate space (e.g. Reading station redesigned to cope with extra passengers http://www.newsteelconstruction.com/wp/other-finalist-reading-station-transfer-deck/

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Locating connecting bus stops in close proximity to a station and away from busy roads can make the interchange and wait more pleasant. Heavy traffic and too much going on can be a deterrent to continue the journey by public transport.

In summary, the factors which play a role in accessibility of stations include:

Potential gaps at stations	Most severely affected user group(s)
Parking (bicycles, shared and private vehicles)	Young people, Families with young children
Presence of seating and shelter at stations	Elderly, Disabled, Women with young children
Physical accessibility (barrier-free access, elevators, escalators)	Elderly, Disabled, Women with babies/ young children
Audio/visual/tactile information and guidance	Disabled, Elderly, Migrants (for those learning the language, pictures and symbols can help for clarity)
Safety (e.g. lighting, security cameras, utilising natural surveillance, e.g. Careful use of vegetation to avoid screening, encouraging land uses which increase human activity and reduce feeling of vulnerability e.g. shops, housing)	Elderly, Women, Young people
Ticket machines (at all stops or only hubs? On vehicles too?)	All
Location of facilities (e.g. to not be too busy or too isolated - minimise feeling of isolation by having cycle parking in clear view, no high walls and tight corners; improve accessibility of bus stops by not having them alongside busy roads - Barrier to elderly, children and people with disabilities)	Elderly, Disabled, Children, Women
Waiting environment that is clean, well-kept and stimulating	Women, Children

Table 4.5: Factors which affect accessibility of stations

Network density & connectivity

Network density tends to be sparser in rural areas, particularly those with difficult terrain and low populations. This can result in poor connectivity and poor access to public transport resulting in isolation particularly for people without access to a car such as the elderly, children and students. For

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these groups the alternative to isolation can be dependency on others for lifts by car to destinations and in this way, they lose their sense of independence. This is then a problem later on for children who grow up without any form of transport literacy and awareness which in turn acts as a barrier to travel by public transport when they do have access to it because they cannot read a timetable or do not even think to see if there is an alternative to a car. Distance between stations /stops can result in gaps in public transport provision as people will be reluctant or unable to walk long distances in all weathers. This is a very real barrier to vulnerable groups.

Connectivity or lack of it has a huge impact on travel choices. Good connecting services can enable rural areas to access the urban areas via feeder services. A long wait or infrequent service can deter travel. Short waiting times between modes are the best for all users. The Swiss railways have been using this approach for over 35 years. Their Taktfahrplan with times of buses, trams etc. feed into well timed connections at rail stations. https://www.sbb.ch/content/dam/sbb/de/pdf/sbb-konzern/sbb-als-geschaeftspartner/bund-kantone/Zuercher-S-Bahn/S_Bahn_Taktfahrplan_ab_15.6.2014.pdf

With regard to shared transport, lack of availability or gaps in knowledge of availability can be a deterrent to making a journey using a shared mode as one segment of the journey. For example, Reading Buses and Reading Borough Council have explored the feasibility of showing on the bus information on the number of ReadyBike cycle share bikes available at the next bus stop on the in-bus information screen.

In some rural areas, connecting services to stations are poor or non-existent. Bus services typically do not cover all areas and there may be a long walk from where someone lives to the nearest bus stop. The nature of the rural roads with no footpath may be unsuitable for walking or the distance may be too far to walk. In some areas community bus services, school buses and special transport to hospitals appointments and day centres for the elderly and disabled help to fill this gap.

In summary, the network density and connectivity factors which play a role in the transport accessibility include:

Potential gaps in network density & connectivity	Most severely affected user group(s)
Distance between stations in relation to origins and destinations	All
Connectivity within the region, especially to urban areas (related to intermodality; see the following section)	All

Table 4.6: Network density and connectivity factors which affect transport accessibility

Information infrastructure

Crowdsourcing data is increasingly used particularly in cities. Citymapper and other apps provide up to date information on all aspects of getting around for everyone and of particular relevance to vulnerable groups, including transport, accessibility for wheelchairs, uneven pavements etc. These

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sources of information are favoured by some vulnerable groups as a useful and easily accessed way to plan getting out and about.

Information from transport providers' websites is available to anyone with access to a computer or smartphone. Google Directions is also used as a useful source to find travel information and to compare travel between different modes.

Traditional transport information centres provided by transport operators are favoured by those without access to digital information and by some vulnerable groups including some elderly people and others who prefer a human contact.

3.2.2 Gaps in transport service provision

Information provision

Real-time travel information e.g. apps, live updates on a screen at stations, destination and next stop information on screen on bus and announcements are of great value to many vulnerable groups since information is given on the actual situation rather than the intended service as in a conventional timetable. RTPI gives a sense of security to the passenger in what to expect of the service at that time. However, this information tends to be concentrated in urban areas with good levels of service. The more remote areas with a less frequent service often lack this information. From the point of view of a person with a disability or a lone traveller, the lack of RTPI is a barrier. For example, it is very important to know if the once every two hours bus is coming. Otherwise when it seems to be late, the passenger does not know how late it is, whether it is cancelled or if it even ran early. Uncertainties such as these can be a very real barrier to travel.

Maps with information are of practical help and can provide easily accessed information. This more traditional means of conveying information should be available on paper as well as digital form. For example, the Reading Cycle map is very popular with residents and visitors especially students since it shows details of favoured cycle routes and what the conditions are like for cyclists e.g. on and off road, single carriage way etc. http://www.reading-travelinfo.co.uk/cycling/network-map.asp

Fear of road safety and a lack of awareness of walking routes is a barrier to British school children who often would like to walk to school but parents worry about road safety. Increasingly councils are filling the gap in information by producing easy to follow maps with suggested safe routes and places for parents to park and stride. In this way, information helps to break through the perceived dangers and the perception that the car is the only option.
https://www.pindarcreative.co.uk/case_studies/living_streets.html

Some passengers need more information or even a personal touch to enable them to make the step to travel. Many local authorities in the UK provided travel planners for this purpose funded by the Local Sustainability Transport Fund (LSTF). These travel planners provided travel information by phone or in person and in some cases accompanied needy passengers on their first trips. There is now a real gap in this service since the end of the LSTF.

In Krakow, a pilot study placed assistants at stations at selected periods of the day to help older people enter and exit buses and trams, to provide information on connections and schedules, and to help with e-ticket machines. During the pilot, up to 120 older persons were assisted daily and high

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levels of satisfaction were recorded. https://www.rupprecht-consult.eu/fileadmin/user_upload/NICHES_downloads2/NICHES_study_tour_catalogue_2011.pdf

In summary, the aspects of information provision which play a role in transport accessibility include:

Potential gaps in information provision	Most severely affected user group(s)
Real-time travel information (e.g. apps, live updates on a screen at stations, destination and next stop information on screen on bus and announcements)	All
Maps (of network, for pedestrians and cyclists)	All
Effective provision of packages of information/ marketing/ service personnel to give passengers confidence to travel	All

Table 4.7: Aspects of information provision which affect transport accessibility

Frequency of service

Transport services in urban areas are often planned around an assumption that a service frequency of around every 15 minutes or less is an optimum frequency, enabling the passenger to simply turn up. Services in rural areas are inevitably costly to run at this level and in these areas the lower level of service can be a gap in provision for many passengers.

A gap in service frequency on weekdays can be particularly inconvenient to young people getting to education and work destinations, children getting to school and clubs, women making multiple trips with young children and covering family needs of shopping, taking children to school, medical checks etc. For women at home with a young family in the day and for the elderly, a lack of good service frequency can impact on their mental health through loneliness and isolation and their physical health as they may therefore go out less.

Buses in rural areas often run less frequently in the evening and at weekends or are non-existent at these times. This impacts in particular on young people who want to go out socially at these times, thus resulting in isolation or dependence on parents for lifts by car. This has a wider social impact in that these young people have the tendency to lack knowledge on how to travel independently by public transport rendering them lost in a large city and also that they see the car as the only option and aspire to owning one as soon as possible.

Compatibility of timing of services within a network for multimodal or multi-trip journeys is important and any long waits between services are likely to be a barrier to women (who can feel insecure waiting for a long time and also job seekers who need to be able to reach potential work in any possible destination.

Long waiting times due to infrequency of service or poor reliability represents a real problem for passengers who find waiting uncomfortable or even impossible. Waiting in cold and wet conditions

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will be tolerated much less than in warmer drier climates. This group includes the elderly, the disabled and women with young children. People travelling to work are also inconvenienced.

Another impact on frequency of service occurs only in the UK where bus deregulation since the 1980s has meant that any competitor can register a bus service to run 3 minutes ahead of the established service to poach passengers. This results in irregular frequencies along a route, rather than an even spread of services across time. Lack of regularity makes the timetable harder to remember and means that simply turning up at the bus stop is not an option. This impacts on all passengers but especially those with disabilities and those with no other means of travel such as young people.

Even in urban areas, bus services can be infrequent at night. The introduction of cycle share in urban areas can help plug this gap in bus services for night workers. For example, the introduction of ReadyBike cycle share in Reading UK in 2014 resulted in a significant usage of bikes at night between the town centre and the out of town business parks.

In summary, the aspects related to frequency of service which play a role in transport accessibility include:

Potential gaps in frequency of service	Most severely affected user group(s)
Weekdays	Young people, Women, Elderly
Nights, weekends	Young people
Compatibility of timing within network (for making intermodal/ multi-seat journeys)	Women, Job-seekers
Long waiting times	Elderly, Disabled, Women with young children

Table 4.8: Aspects related to frequency of service which affect transport accessibility

Reliability of service

When delays to a service are frequent, then passengers perceive the service to be unreliable. Passengers may tolerate an occasional delay but once this becomes frequent, the impact can become intolerable for people travelling to work and also for vulnerable users, in particular the elderly, disabled and those with young children who may find waiting physically uncomfortable and also stressful and unpleasant.

Timely and adequate information on delays can help people plan an alternative route or time to travel. For example, Network Rail in the UK advertises delays scheduled due to engineering works around 6 weeks ahead which helps with planning journeys. By contrast, strikes at short notice on Southern railways network has become so frequent over the last years that passengers have opted not to travel by train any more. http://www.bbc.com/news/uk-england-37443025. For those groups with no alternative but the train, this lack of reliability can result in them stopping travelling resulting in isolation or becoming dependant on others for lifts. Neither is desirable for vulnerable groups.

A lack of up-to-date timetables is a particular problem for passengers in the UK where bus deregulation means that services can be registered and changed and re-registered at short notice. This makes it difficult to have an up to date timetable for a given route and the gap in information

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reduces the trust in any timetable whether it is on line or at the bus stop. Traveline - http://www.traveline.info/ is an online service that dies its best to keep up to date with services throughout the UK – urban and rural but it is still hard to achieve a fully up to date service and therefore passengers are left with some doubt as to whether their bus will run. Where there is a choice to travel by train this is seen as a service that will run as advertised, where there is no alternative, passengers are left with the bus service which unless they are a very frequent traveller able to converse with the driver they may not know if the timetable they have is the current one or whether the bus service has been cut.
http://www.dailyecho.co.uk/news/9147785.Rural_bus_routes_at_risk_from_cuts/

In summary, the aspects related to reliability of service which play a role in transport accessibility include:

Potential gaps in reliability of service	Most severely affected user group(s)
Frequency of delays	All
Timely and adequate information on delays	All
Up to date timetables available	All

Table 4.9: Aspects related to reliability of service which affect transport accessibility

Ticketing and payment systems

Measures to provide free local public transport to vulnerable groups are commendable but do not always reach the neediest. For example, in the UK free off-peak local public transport for everyone over 60 years old enables the elderly to access free local transport. Some even use it to travel to work. However, other less well-off groups such as the low paid or young people are faced with ever increasing fares in rural areas to cover the running costs. In some areas, buses at travel to work times are cut in favour of the buses running off peak times which are well loaded with elderly passengers with passes. Increasingly, travel to work is done by car in these areas. http://www.dailyecho.co.uk/news/9147785.Rural_bus_routes_at_risk_from_cuts/

Various payment systems occur across the EU to enable students, job seekers, those on a low income, the elderly and young people to travel at reduced rates or for free. However, these are not universal and the availability of these free passes and reductions varies from country to country and from municipality to municipality. For example, students have free travel in the Netherlands but students in the UK have no free travel but can purchase a student rail card to get off peak reductions and, in some cities, there is a reduced multifare ticket scheme and in other areas there is not.

A choice of payment system enables passengers to choose the method of payment easiest for them. To maximise the choice, ticket machines at stations and stops should be at varied heights to suit wheelchair passengers as well as others who are using standard height machines.

Smart ticketing bought on line is becoming increasingly popular. This is a convenient system for many but other options for those without access to a computer or with little computer literacy help to bridge the gap they face. It is noted that Swedish railways took the decision some years ago to close all ticket offices at main stations. Some elderly people and others such as those facing anxiety

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do prefer the human touch and to be able to have a conversation before deciding on what ticket to buy.

In summary, the aspects related to ticketing and payment systems which play a role in transport accessibility include:

Potential gaps in ticketing and payment systems	Most severely affected user group(s)
Price (overall, schemes for students/ commuters/ low-income/ elderly, etc.)	Low-income, Elderly, Young people
Payment system (e.g. existence of ticket booths, machines, apps, integrated ticketing)	All

Table 4.10: Aspects related to ticketing and payment systems which affect transport accessibility

Intermodality

Integration of modes across a city and region is commonplace in major cities across Europe e.g. Vienna, Paris, London. In smaller towns and rural areas there is less opportunity for intermodality and thus people miss out, especially women and jobseekers who are dependent on a good multimodal system to get them to work and to access other services.

Multimodal hubs can increase awareness by their very presence in the streetscape and hence encourage people to try a multimodal journey. For example, a bike share docking station next to a bus stop can encourage onward travel from the public transport network to remoter areas and for those living outside the public transport network to feed into it.

Shared transport, including car share and bike share, provides more links into the network and is more inclusive, enabling more people to connect with the public transport network, especially those outside of an urban public transport network.
https://www.carplusbikeplus.org.uk/project_page/cornwall/

Encouraging active travel to connect with other modes, as well as a mode of transport in its own right, encourages vulnerable groups to be more active and can enable them to bridge the gaps in transport provision. This brings public health benefits as well as increased accessibility e.g. Beat the Street piloted in Reading with a target to attract people with long term medical conditions and now encouraging active travel world-wide. http://www.intelligenthealth.co.uk/

In summary, the aspects related to intermodality which play a role in transport accessibility include:

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Potential gaps in intermodality	Most severely affected user group(s)
Integration of mobility services (e.g. across modes, across the city and region)	All (but particularly Women, Job-seekers)
Presence and functionality of multimodal hubs	All (but particularly Women, Job-seekers)
Links to shared transport to feed into public transport	Elderly, Disabled

Table 4.11: Aspects related to intermodality which affect transport accessibility

Having listed gaps in public transport provision in the eyes of vulnerable user groups, transport poverty can be more complex. The features of a transport system that have potential to present barriers impacting on user groups are many and include those listed below, which are experienced differently by many groups of society:

- Literacy: The possibility to read transport relevant information and to comprehend the transport system and the way it is used.
- Price: affordability/ability to pay for the required journey
- Safety – twofold:
  - Actual traffic safety and resulting trust in the safety of a transport system
  - social safety: actual crime vs. perceived crime rate
- Distance/physical access: the actual distance to transport modes and the physical access aspects of the transport mode
- General price development: example: If rent and commodity prices rise, people's mobility budget is reduced.

In this way, the personal circumstances of much of the population can dictate whether or not they fall victim to gaps – or unmet needs – in the transport system. And these personal circumstances can change for individuals over time. For example, a change in location of the home of an elderly person or the rising housing costs for women with children may mean they can no longer access the transport system as easily as they used to.
In conclusion, the nature of gaps in transport provision is related directly to the circumstances – and consequently the needs – of the users. In this way, generalisations can be made regarding how gaps impact on people with disabilities, the elderly and so on. However, the overall impact on individuals is such that no-one is immune from the need to fill transport gaps. Therefore, this approach to identifying transport deprivation is of universal importance to all user groups. (Reference: Prof. Rob van der Bijl, Ghent University)

4.3 Identification of major user needs (MEM (R), UNIABDN (C), RUPPRECHT (C), MOSAIC (C))

It is duly recognized that sustainable mobility cannot be achieved without an efficient, extensive and accessible collective transport system (Ambrosino et al., 2016) (see also the approach towards the

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provision of an integrated mobility offer centred on conventional and flexible services described in section 3.1). Providing an accessible transport service for all users is a key factor in ensuring people are able to reach places of employment, leisure, education, healthcare, etc. Additionally, the changes driven by trends such as urbanization, urban sprawl, flexible economy, transforming households, and evolving lifestyles increase travel (in terms of number and length of trips, transport modes and interchanges) and enlarge the "inter-connected" area: from suburbs and peripheral surrounding areas to city centres, among satellites and different districts of the same "functional" urban area, from rural areas to main villages/small urban areas, etc. Many sectors of society, such as the elderly, children or low-income persons, are dependent on the available public transport as their sole/primary means of access to the various destinations. If the service is inadequate, they must either persist in their travel in sub-optimal conditions, or they must forego the trip altogether. In this sense these PT user group are indicated as "disadvantaged" or "vulnerable".

Despite great efforts in the last decades to improve public transport quality in all Europe's countries, Public transport offers are not completely able to meet the evolving expectations of a wide range of customers. In particular, the gap which needs to be filled is the customisation of service schemes to specific needs of target groups and local contexts and the "virtual" accessibility to services. Moreover, the disadvantaged/vulnerable groups present different travel needs (access to education, work, healthcare, etc.), and are affected in different ways by existing transport gaps: the strategies and actions aiming to improve public transport quality must therefore be specifically tailored to user needs and criticalities (even more now than in the past) and build on the integration of the different transport modes into an accessible transport system.

The aim of this section is to identify the major user needs and unsatisfied mobility requirements for target user groups identified in section 2.3. The analysis of the specific user needs related to the six Pilot Labs is then reported in section 3.4.

4.3.1 Unsatisfied mobility requirements for identified user groups

Travelers can be characterized by different travel needs. These needs depend on their commitments, lifestyle choices and constraints, both in terms of time and money, which vary across different socio-demographic variables, such as household composition, income level, profession, car availability and they are finally reflected in different preferences to transport mode and use (Susilo et al., 2014).

The success of any transport service is strictly related to its ability to meet the needs of the target users. When referring to an existing service, experience shows that the service features are very often defined based on PT operators' needs, stakeholder constraints and former customer surveys rather than on a real assessment of the evolving needs of target users and potential customers, needs which are not identified in some cases. When referring to a new potential service, there is a clear need to first define who are the potential users and then, when the users are known, their needs can be more clearly identified.

Taking into account the results of section 2.3, this section analyses in depth how user needs can vary according to demographic, socio-economic and behavioural characteristics of users in relation to different transport environments. The main results of this section come from an analysis of the

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reports of previous projects in the mobility domain, from literature reviews and the knowledge of the project consortium.

4.3.2 Needs related to the demographic characteristics of identified user groups

AGE

It is unquestionable that peoples' mobility needs change with age, and the ways in which age may impact upon mobility needs have already been detailed in section 2.3.1. The five major age groups and their related percentages[4] in relation to the EU population are shown below in table XXX.

Age group	Age	% on EU population
Children	0-14 years	15.5%
Students/early workers	15-24 years	10.9%
Working age	25-54 years	41.8%
Mature working age	55-64 years	12.9%
Elderly	65 years and over	19.1%

Table 4.12: % of EU population by age group

Children (0-14 years)

As stated in section 2.3.1, children travel mostly for educational purposes during peak hours and recreational activities on low demand hours; being unable to use a private transport mode (with the exception of bikes), they are generally heavily reliant upon their parents (or other carers) and PT services for mobility requirements. In the last decades, what has been found is an increase of the amount of travel for educational purposes covered by private car instead of other modes (and in particular instead of walking or cycling). This has been mostly attributed to two factors:

- Longer journeys to be covered, more likely to be made by car
- A higher perception of risk from parent's side.

A recent study (Beuret, 2016) has indicated that perceptions of risk and fear of strangers from parents are higher so children are less likely to travel independently than in the past. For example, research led by the Policy Studies Institute (Shaw et al., 2013), has found that over the past four decades, primary-school children in England have lost much of their freedom to get about in their local neighbourhood without adult supervision. This loss of independence applies to their leisure and recreational activities as well as to their travel to and from school. Only 25 per cent of primary-school children in England are allowed to travel home from school alone, compared with 86 per cent in 1971.

[4] https://www.indexmundi.com/european_union/age_structure.html

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By the considerations above, in rural and peripheral areas where walking to school becomes very difficult due to the long distance to travel, PT services can be a valuable solution, especially in case of lack of household car ownership. In order to ensure a high feeling of security and safety, an efficient solution may be organized school transport routes or self-organized school buses (for details see section 2.4.5).

Students / Early workers (15-24 years)

Public transport plays a key role in access to education and to jobs for this age group, especially for young people living in rural and deprived areas and for those with a low-income and/or disadvantaged background. Thus, among other factors such as the location of schools, enrolment in secondary and further education is contingent on the pupils' proximity to school and mobility potential (Cook et al., 2005). Moreover, the evidence shows that children from low-income families travel a shorter distance to school than their high-income counterparts. Storey and Brannen (2000) found that young people in rural areas had particular problems in accessing education and maintaining a social life.

It should be noted that older teenagers find practicalities (such as cost and speed of journey) to be more important in determining their travel choices (TfL, 2008). In addition, the availability and affordability of public transport are also matters of concern for young people in relation to job access. Recent studies have indicated that young and low-income persons have less access to private transport, so they could be most likely to use public transport services. In addition, the use of Public Transport services also has a direct benefit in terms of health. Evidence resulting from the *Australian Victorian Integrated Survey of Travel and Activity* (Department of Transport Victoria, 2007) shows that people who used public transport on a given day also spent an average of 41 minutes walking or cycling as part of their travel, as compared to only 8 minutes in the case of private transport users.

It is clear that in order to improve the accessibility and inclusivity of rural, peripheral and deprived areas, PT operators should try to develop integrated transport services in order to meet young peoples' requirements to access education, cultural and leisure activities, and indeed jobs.

In the last two decades, particular attention has been paid to the impacts of transport systems on young people's behaviour; Public Transport Authorities and Operators have put much effort into improving public transport service provision especially in rural and peripheral areas in order to meet young people's specific requirements (e.g. public transport services during the night, dedicated tariffs etc.). In order to achieve this goal, the availability of smart technologies (i.e. "virtual" and/or "remote" platforms) can be an interesting solution to be explored by PT operators in order to answer to low demand areas' needs.

Working age (25-54 years)

In the last decades, what have been observed in Europe and in several developed countries across the world is "car-oriented" behaviour: among Europeans aged between 25 and 54 years, 62% a use a car every day as either a driver or passenger (European Commission 2013). Furthermore, the increased flexibility of working activities has produced an increase of flexible demand compared to "systematic" ones (both in terms of time of travel and origin/destinations covered). In rural and peripheral areas PT transport services have been usually designed to answer commuting needs of residents for works and education but it is less responsive for dispersed mobility which is mainly

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represented by families with young children (from the INCLUSION proposal). In particular, families with children are more likely to be "vulnerable" PT user groups compared to families without children. This occurs when the number of available cars is lower than the number of working parents: in such a case, some of the family members (generally children) must rely on collective or alternative transport modes to move.

Barriers to the use of public transport are less binding for households with no children, compared to households with children. When referring to the target groups using PT to travel from home to work, punctuality and reliability, more than the cost of the services, become key factors in decisions regarding transport modes (Li, 2003).

*Mature working age (*55-64 years) and *elderly (65 years and over)*

As stated in section 2.2, the percentage of elderly is growing due to increasing life expectancies and an overall decreasing fertility rate across Europe (the aging trend). The elderly tend to have more limited ability and strength to move and the feeling of being able to travel independently is closely linked with a sense of self-worth. They have increased difficulty in identifying signs, in reading timetables, listening to loudspeakers: for this reason, the availability of accessible public transport services is thus of primary importance for the quality of life of the elderly.

Another matter of concern for the elderly is physical access to public transport. Mobility problems, as well as sight, hearing and cognitive impairments, make older people more sensitive to poor-quality transport services and vehicle design (e.g. high steps to access trains and buses, lack of elevators or moving stairs in interchange stations, timetables and information written in excessively small letters, etc.). Given that age and mobility-impairment are intrinsically linked, the key points related to older people needs are the following (Compass, 2012):

- In many respects the transport needs of older / mobility impaired disabled differ very little from the general population as a whole, although for some user aspects, their requirements are of a different nature / or are amplified;
- Older peoples' requirements are related to being able to board and alight from vehicles safely (accessibility issues), transport staff understanding their specific needs, assistance or ease of carrying bags/luggage.
- In addition to more frequent and reliable services, more comfortable and lower cost services, and improving access for older people are key priorities. Many priorities also relate to the "virtual mobility" aspects, i.e. the way in which services are delivered rather than the actual services themselves. In particular, improving attitudes of transport staff is perceived as a key issue.
- Older people have special needs and requirements with respect to intermodality, specifically in relation to aspects such as baggage handling, accessibility of interchanges and user-friendly information.
- Accessibility needs, including reaching transport stops (or, alternatively, to access "door-to-door" services) and boarding and alighting vehicles, are the main issues for mobility-impaired travellers and for the elderly, as well as adequate information provision, more so for visual

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and hearing-impaired travellers, feeling safe and secure when travelling, and cost, as many mobility-impaired people are on low incomes.

- As well as the more general information needs of all travellers, older people need to know if the network is adapted for them before starting the trip; key information needs include if there is an elevator at the interchange station (especially for persons in wheelchairs), if the buses are low platform, if the bus is equipped with wheelchairs elevators, and how to use the elevator (in case the bus is so equipped).

From the previous considerations, accessibility issues are the main requirements, relating to accessing services, vehicles and interchanges, although understandable information provision and staff assistance are also key requirements.

SEX

Several studies have indicated that there are significant gender differences in mobility patterns and travel behaviour. First, it should be noted that men are more likely than women to use a car daily (57% vs. 42%) (European Commission 2013). A study for the European Parliament (2012) provides literature evidence on the mobility patterns of women, showing that besides using public transportation more than men (Rosenbloom, 2006), women are also more likely to engage in non-work travel (Vance and Iovanna, 2007), to make more multi-stop journeys, to run household errands and to accompany other dependent passengers (usually children or the elderly) (Murakami and Young, 1997; Root, 2000; McGuckin and Nakamoto, 2005).

For women, mobility is affected not only by availability and access to public transport; safe/secure, affordable, reliable and efficient transport services are crucial in relieving the time burden of their workload and facilitating their economic empowerment. In particular, personal safety is a key concern for them. Women can be deterred from using public transport if they do not feel safe. They may not want to wait for public transport for fear of harassment and are therefore less likely to use transport services with a random or unreliable schedule or at night (Department for International Development, 2013).

Overall, these differences in mobility patterns and travel behaviour do not determine directly different mobility needs in women and man, rather some women do attach greater importance to certain aspects. A summary of the main findings from the literature review (Compass, 2012) is briefly summarized below:

- *Accessibility*: Women often make 'encumbered' journeys, i.e. travel with luggage, shopping, or young children, and in these cases share similar problems in using buses as those with restricted mobility, and are thus likely to have similar needs. Accessibility needs are more relevant for woman travelling with children, especially in relation to boarding and alighting vehicles (especially with buggies) and buying tickets as their journeys tend to be more complex, often involving multiple-stages;

- *Reliability*: Reliability of services is more relevant to woman, especially those travelling with young children, in that unreliable services cause long waits at bus stops, sometimes in bad weather;

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- *Cost*: Public transport cost is particularly relevant for woman on low incomes;
- *Information provision*: Due to often complex journeys that females make (e.g. dropping children off at school, then travelling to work, then collecting children from school) information regarding intermodal/trip chains is often not available; and
- *Personal safety:* The most consistent finding to come out of these studies relates to differences in the level of importance attached to personal safety issues, i.e. woman have a greater sense of:
    - Fear of sexually related violence;
    - Fear of crime generally;
    - Travelling at night; and
    - When walking and cycling generally (Ravenscroft et al. 2002; Dickinson et al. 2003).

DISABILITY

Disability is a multi-dimensional concept, arising from the interaction of health conditions and the environment (World Health Organisation, 2001). Persons with disabilities can be affected by motor, visual, hearing or cognitive impairment and each of these limits can restrict people's ability to move on their own.

It is well known that the share of people affected by disability or longstanding health problems tends to rise with age and that disability prevalence among people aged 65 or more is much higher compared to younger people. In fact, at the EU level, the disability prevalence among elderly people aged 65 and over is about 54% compared to 18% among persons aged 16 to 64 (EU-SILC 2011).

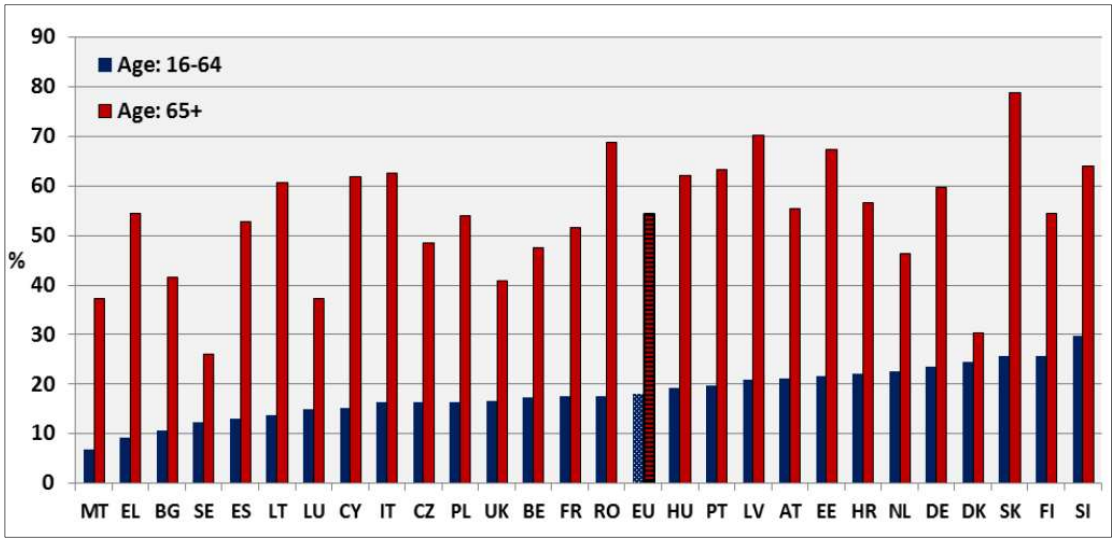

Table 4.13: Persons with disabilities by age group, 2011

Source: EU-SILC 2011

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In many countries, persons with disabilities and the elderly are more likely to be among the poor, as their livelihoods and economic opportunities are limited as they are often excluded from basic necessities such as education and employment, health care, and social services as well recreational activities because they face barriers to accessing transport services. Accessible transport is an important factor in reducing poverty as it can facilitate the participation of people with disabilities and the elderly in economic, social and political processes. Moreover, an accessible transport system promotes independence and choices for people with disabilities and the elderly (UNDP, 2010).

Therefore, for this target user group accessibility is the key word. If any transport service does not ensure sufficient accessibility standards, it cannot be a consistent alternative for a person with a disability who wants to travel. However, it should be noted that is not an easy job to link disability to specific mobility problems and needs, because knowing that a person has a disability does not reliably indicate whether that person faces significant mobility constraints. For example, some people have such severe disabilities that they cannot leave their houses without substantial assistance, which may mean that their transportation concerns are secondary to the other barriers they face.

Moreover, barriers to mobility have complicated causes. For example, Rosenbloom (2007) looked at the impact of income level on mobility patterns finding that almost all transportation problems among the elderly and among people with disabilities are related to low-income level or income alone; transportation problems dropped drastically with rising income, even controlling for age, physical disability and health status. For what concerns mobility issues, the main impairment is usually difficulty in walking and/or driving a car, followed by vision problems and cognitive or mental problems. Another key issue related to the use of public transport is the need for help from another person.

Policies and regulations can also create barriers for persons with disabilities. This may be regulations that ban passengers who travel in wheelchairs from deep underground metros because of the difficulty of evacuating them in an emergency; or a health regulation that bans dogs, including guide dogs, from shops, hotels and restaurants. These examples demonstrate that even as measures are designed to improve some situations, caution must be exercised so that these measures do not unintentionally erect barriers for the disabled. Environment and vehicle design can also create barriers for persons with disabilities.

Research conducted in Australia (Getting There and Back and Rural Access Projects, 2009) found that the most common reasons given for not using public transport were lack of physical access, the fact that it is not available or that it does not suit the transport need. Other reasons were that information about public transport is not available, it takes too long or is cost prohibitive.

To sum up, the main needs of persons with disabilities are related to the following (UNDP, 2010):

- **Transport station and pedestrian environment**

A survey conducted by the Disabled Persons Transport Advisory Committee (DPTAC, 2002) on disabled people in England and Wales shows that poor condition of the pedestrian environment was of greater concern than dissatisfaction with public transport. Aspects of the pedestrian environment that cause difficulties for people with disabilities include features, such as hills, narrow or uneven sidewalks, and crossing roads, which affect everyone, though people with disabilities are more affected. Other features, such as crowds, kerbs and steps, mainly affect people with more severe

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impairments. The most common barriers are bad surface quality and obstructions in the form of poles, kerbs, parked vehicles or traders.

- **Vehicle design and operation**

Many of the ergonomic and design requirements for vehicles are the same for buses, minibuses, light rail and heavy rail. For public transport, there is a distinction between two different levels of accessibility. The first improves access for those people with disabilities who can walk, but with difficulty, and can climb at least a few steps. These design features often cost very little and can assist over 90% of people with disabilities. They also assist many non-disabled people. The second level of accessibility enables a passenger in a wheelchair to board and travel in public transport. This level of access may improve ease of use for all passengers, as in the case of low-floor vehicles or level boarding from a platform. But if access depends on the use of special equipment such as a lift, most passengers gain no benefit. In Europe, the accessibility of buses has been improved through the development of low-floor vehicles. An alternative to low-floor buses or mechanical lifts is to use roadside structures raising the passenger to the approximate height of the bus floor, in conjunction with bridging plates and appropriately designed bus interiors

- **Information**

Signage and information is important for all passengers, but especially for persons with disabilities. They need to know when to catch public transport, which route or service to take, how much the fare is, and where to find a specific train, bus or minibus within a station or rank. Information should be clear, concise, accurate and timely, and should include information on accessibility. Signs should be well lit. The SEU study (2003) notes the often very small print used for timetable information, which can also be complicated and difficult to understand and Lamont et al. (2013) also underline the importance of accessible transport information systems for people affected by dyslexia.

- **Training and policies**

Wherever public transport services have become more user-friendly towards persons with disabilities, the training of staff, managers and officials has been an important element. The needs of people with disabilities can best be served if staff are not only courteous and helpful, but are also equipped with specific knowledge on how to serve people with special needs. Nevertheless, transport staff are sometimes unaware of the needs of persons with disabilities and may not always be available or able to provide the required support.

MIGRANTS

Immigrants may face several mobility challenges, some of which are related to socio-economic characteristics (such as having a low income), while others may arise as a result of language or cultural differences. Based on focus groups conducted with immigrants living in Austria, Belgium and Norway, Assum et al. (2011) concluded that barriers faced by immigrants were broadly similar to non-immigrants, although some aspects were more relevant for immigrants when they first moved to a city/area/country, namely:

- *Problems with information*, due to lack of understanding of the native language. For example, people in Black and Minority Ethnic often have difficulty understanding transport information

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if not presented in their own language, which can impact on the types of travel modes they use (Wixey et al., 2005);

- *Problems of understanding how public transport services operate*. It could be that some immigrants are not familiar with local services (times, routes, connections, etc.) and this barrier prevents them from using public transport;
- *Low frequency*: many migrants may live on the surrounding or peripheral areas of cities which have fewer available transport services;
- *Costs*: for some immigrants, cost of public transport services act as a barrier (although over time as they find employment this barrier diminishes); and
- *Feeling safe walking/travelling at night*. BME persons (particularly Asian persons) living in the UK, for example, expressed greater concerns walking to and from bus stops or whilst waiting for buses during the evening/night time, compared to non-BME people (Crime Concern, 2002).

STUDENTS

As indicated in Section 2.3, students may face particular mobility challenges associated with competing needs of class scheduling, limited access to private transport, and (in many cases) irregular working hours. Europeans aged 15-24 are by far the most likely group to use public transport at least once a day (38%), which is 21 percentage points higher than the next most common group (25-39 year olds at 17%). Students are the occupational group who are most likely to use public transport at least once a day, with nearly half of students reporting this level of use (49%). While access limitations are likely to be lower given the relative disability levels of this age group compared to the elderly, as well as less complex familial needs in general, issues of travel cost and proximity of transport services relative to the living areas of this cohort may still present barriers. Additionally, more irregular patterns of travel (associated with changing class schedules, working hours in employment sectors that have shift-work or service models, and more late-night trips) may make traditional models of service based on peak-hour commuting less effective for serving this cohort.

4.3.3 Needs related to the socio-economic characteristics of identified user groups

INCOME LEVEL

Income levels may affect mobility needs. First, it must be noted that the possibility of keeping and using a private car is much lower for low-income people than that of mid-high-income users. For example, people who almost never have difficulties paying bills are more likely to use a car on a daily basis (52%) than those who have difficulties paying their bills most of the time (37%) (EC, 2013).

Moreover, the need for public transport services is strongly linked to the area type where the user is travelling from/to. In metropolitan areas, public transport is important for persons with low incomes because it allows them to move from residential areas to workplaces without having to take the private car. Also, the availability of public transport services plays a crucial role in the choice of an individual to accept a specific job in a specific place (Department for Transport, 2013). Contrariwise,

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in rural areas public transport designed through fixed route services is not able to meet people's needs. As already stated in section 3.1.6, walking and bicycle trips are not a significant option, and in many such communities where transport services are limited and time-consuming, most families use car trips for most job and job-related trips. This is confirmed by the evidence that using public transport at least once a day is much more common among people living in large towns (31%) than among those who live in small/mid-size towns (13%) or rural areas (8%). Four out of ten of those who live in rural areas never use public transport (40%), compared with fewer than one in five of those who live in large towns (14%).

Bus travel is particularly important for people on low incomes. The 2011 NTS confirmed that people in the lowest income bracket make almost four times more journeys by bus than people in the highest income bracket (DfT, 2011). A study conducted by Duffy in 2000 found that bus services were more important to respondents in deprived areas compared with those in non-deprived areas, and that improving bus services was seen as a relatively high priority in deprived areas compared to other, more affluent, areas.

For this target user group, another matter of concern is the cost of transport, and it is clear that low-income people tend to be captive to the cheapest mode alternative and spend a significant proportion of their income on travel. The high costs of car-based transport (especially when configured as single-occupant trips) can trap low-income families in poverty, since the lack of transportation is a major disincentive to employment (Zhao, 2013).

Finally, persons with low-incomes are also more likely to face problems of physical access to transportation, given that, according to social research, low-income people are more likely to be physically disabled or to have children (Bradshaw et al., 2004).

EMPLOYMENT

Among occupational groups, managers are most likely to drive at least once a day (73%) and manual workers are least likely (64%). Around seven in ten of self-employed or white-collar workers (71% and 68% respectively) drive at least once a day. These figures contrast with homemakers (37%), unemployed respondents (35%), retired respondents (30%) and students (31%). Transport plays a major role in the decision-making process about whether to apply for, accept or stay in employment. Around 40% of jobseekers say that a lack of personal transport or poor public transport is a key barrier preventing them from getting a job (PTEG, 2011; SEU, 2003; DfT, 2000).

Jobseekers spend a lot of time and resources in travelling for job interviews and the cost of transport may be a problem getting to interviews. The most common measures implemented in some EU member states to address the needs of jobseekers (and unemployed persons) is the provision of reduced fares or free passes, as well as specific services for deprived areas. As an example of this measures, in the "Workwise Project", developed in West Midlands (UK), Public transport supports jobseekers (unemployed and not on a Work Programme) on their journey to work by providing free tickets for travel to job interviews and free travel passes to get to new jobs for eight weeks[5]. Another example related to the increase of the availability of PT in deprived areas is "Joblink": this initiative, operating across Merseyside, Halton and Deeside (UK), uses timetabled bus services to link deprived

[5] https://www.networkwestmidlands.com/offers/jobseekers/

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residential areas of high unemployment to key employment sites. Additionally, where no fixed route service is in operation, a demand-responsive, door-to-door service is offered to people referred by key partner organisations.

4.3.4 Needs related to the behavioural segments of identified user groups

The classifications of users based on behavioural characteristics are varied. In section 2.3.3 the classifications made by Anable, Prillwitz and Barr and Hildebrand have been briefly presented and many studies are currently trying to analyse and classify users by behavioural segmentation. It is unquestionable that the user's needs determine travel behaviour: for instance, if you need to go to work you have to find a way to reach the workplace. But it is also true that the user's behaviour determines some particular needs: for example, a "Malcontented Motorist", who probably uses a car daily, needs to have valid alternatives (in term of affordability, time travel etc...) to the private car in order to change transport mode.

By analysing the behavioural characteristics of users, and their attitudes towards different modes of travel, it is possible to try to understand how to encourage users to make different choices when approaching the private car. Taking into account the classification made by Anable, the main characteristics, issues and challenges of the different users are presented below. Moreover, for what concerns a possible awareness campaign on public transport, a level of difficulty in intervention is reported.

- ***Malcontented Motorists***

Car ownership: Yes

These individuals exhibit a high moral responsibility to reduce car use, an above average willingness to sacrifice for the environment and a feeling of guilt when the car is used unnecessarily. They stand out due to their frustration with congestion, but they enjoy car travel and believe it would be difficult to reduce. Although they could be willing to reduce car use for altruistic motives and to avoid congestion, they are held back by weak perceptions of behavioural control.

Difficulty in awareness raising: Medium

Needs:

  - More persuasion that reducing their own car use will make much difference, as they believe other people will not reduce theirs (efficacy).
  - Campaign to show the benefits of using public transport.

- ***Complacent Car Addicts***

Car ownership: Yes

This group do not see many problems with using a private car. They are not attempting to limit its use for environmental or any other reasons and exhibit low participation in green behaviours; in

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short, this group does not see any reason why they should reduce car use. They are less likely to believe that their lifestyle can be adjusted to living without the car. This suggests the obstacles to using alternatives to the car are related to a lack of awareness of the environmental implications of behaviour and a moral imperative to change.

Difficulty in awareness raising: Medium

Needs: Campaign to promote the use of sustainable transport.

- ***Die Hard Drivers***

Car ownership: Yes

This group exhibits the lowest desire to reduce car use and the highest psychological car dependency. They particularly enjoy car travel and, despite claiming to be more concerned about the negative effects of car use, they are unwilling to sacrifice their habits for the sake of the environment and feel strongly about an individual's right to use a car. They perceive the highest number of obstacles preventing the use of alternatives, particularly time constraints.

Difficulty in awareness raising: High

Needs: TBD

- ***Aspiring Environmentalist***

Car ownership: Yes

This group feels the most responsible for environmental problems. Pro-environmental behaviour is seen as important and worthwhile, although they are reluctant to completely forego vehicle ownership. The negative effects of car use clearly enter into the decision-making process. They don't enjoy travelling by car; however, they are not overly concerned with congestion as their complaint with the car is broader than this. Nevertheless, they still judge public transport to be problematic and they feel more restricted by time constraints and other obstacles. Both moral norms and attitudes contribute to a high propensity to use alternatives.

Difficulty in awareness raising: Low

Needs: TBD

- ***Car-less crusaders***

This group has more romantic views towards the value of nature and their behaviours favour alternative modes. Due to their high sense of environmental awareness and concern and fewer perceptions of the difficulties with alternatives to private cars, they have foregone car ownership.

Difficulty in awareness raising: Low

Needs: None.

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- ***Reluctant Riders***

This group does not appear to be particularly motivated by environmental issues; rather they are like "involuntary" users of public transport. Despite moderately high concern for the negative effects of car use, they are more reluctant to sacrifice for the sake of the environment. Of the two non-car owner groups, it is evident that these individuals are less content with the use of alternatives. Although time constraints are not a particular problem, a high number perceive many problems with using public transport. This suggests that this group uses alternatives less voluntarily as they are not motivated by altruistic motives and perceive many constraints with their use. Their older age profile and lower income point to 'actual' constraints on behaviour.

Difficulty in awareness raising: Low

Needs: TBD

4.3.5 Knowledge of travel requirements based on real-time data

Digitalization is changing the consumers' experiences and expectations of the mobility system. On one hand, users require mobility solutions that make their daily mobility simpler, more flexible, faster, more reliable and affordable. On the other hand, cities and organizations need to face the challenge of reducing costs, space requirements, noise and pollution, and enhancing efficiencies to have greater collaborations or more innovation for businesses, consumers, society and the environment.

The adoption of digital technologies will provide connected platforms and networks necessary to easily collect different types of data (Table XX). This data will be more accurate since it will be gathered in real-time through the use of IoT to deliver services more safely and efficiently.

Categories	Real-time Data
Vehicles	Location, occupancy level, vehicle status, presence of on-board staff, etc.
Travelers	Time and location of entering and leaving, individual preferences and final destination, ticketing data, routing path selected, emotions (e.g., satisfaction, dissatisfaction…) etc.
Infrastructure	The status of transport links (e.g., congestion or traffic volume) the number of people in a certain location (e.g. at a bus stop), real-time timetables, traffic facilities (e.g., signals), road construction
External	Weather, Events,

Table 4.14: Data categories

All of these different types of data can either be provided automatically or via travellers themselves through different smartphone applications. Real-time open data also facilitates linking of transport modes, opening up new possibilities for passengers.

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Vast quantities of real-time data are collected every second and efficient management and correct usage are key issues to achieve the full potential of IoT. The profound value of this information is that real-time data has the potential to impact strategic transport planning (by creating mobility patterns and travellers' profiles based on historic data analysis) as well as real-time decisions made by transport operators and travellers (Davidsson et al., 2016).

To provide a customer experience-centric value proposition service (Point 3.1.5) requires taking into account travel requirements and traveller's opinions. Public transport is getting personal, passengers now have access to more travel options and real-time status that gives them power, meaning the choices they make influence the services and business models offered by the mobility system (Zarmpou et al., 2016). Additionally, travellers also have high expectations of operators' reliability and customer service.

Transport operators and the whole mobility system will need to fulfil travellers' requirements and be more dynamic and accessible offering multi-modal transportation personalised for each of them. It will be crucial to manage well who controls information and how it is shared in order to be able to meet mobility demand and encourage users to modify their behaviour rather than dictate routine.

4.3.6 Towards flexible tariffs and dynamic pricing

Mobility systems have evolved quickly, and new business models are being created to respond to increasing user requirements and satisfy their mobility needs. Old fixed tariffs are being replaced by **dynamic pricing strategies** in private transport or by **flexible tariffs** in public transport.

On one hand, dynamic pricing for mobility has been recommended as a real-time control strategy to **reduce congestion**, **encourage the efficient and safe movement of people and goods** and to **promote accessibility** (referring to both the first and last mile problem and to the significant Human Rights Issue) (Darst, 2016). When adopting dynamic pricing strategy, different factors should cause prices to change. The Internet of Things (IoT) and digitalization have created a new set of opportunities for customer-centric management mobility services that are tailored to personal consumption patterns. Some of these examples are mentioned below:

Innovative services like 'Uber'[6] use dynamic pricing to manage their services, using a 'Surge Pricing model' when demand for rides increases. In times of very high demand, fares may increase to help ensure those who need a ride can get one. When so many people are requesting rides that there aren't enough cars on the road to serve them all, some riders will choose to pay while others will choose to wait a few minutes to see if the rates go back down to normal. To calculate prices, Uber takes into account the estimated time and distance of the predicted route, estimated traffic, and the number of riders and drivers using Uber at a given moment.

The same situation repeats itself for parking a car: 30% of cars in congested downtown traffic are looking for a parking spot (Xerox, N.D.). Dynamic pricing can help by adjusting toll and parking rates to demand; thus traffic planners gain a powerful tool for managing traffic flows. In this case, the idea behind dynamic pricing is to spread the load of peak driving and parking to change behaviours and promote increased occupancy-per-car (e.g., car sharing and ride sharing), to reduce travelling during

[6] https://www.uber.com/en-ES/drive/partner-app/how-surge-works/

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busy times, to promote parking in underutilized spaces (cheaper or free spaces further away), and to give travellers alternative modes of travel (e.g., public transportation, cycling or walking).

Another example of dynamic pricing application is with electric vehicle charging processes. When clusters of electric vehicles charge simultaneously in urban areas, the capacity of the power network might not be adequate to accommodate the additional electricity demand. Real-time dynamic pricing strategies can help to overcome this problem (Latinopoulos et al., 2017).

On the other hand, flexible multi-modal tariffs in public transport have evolved by being adapted to the different segments of passengers' demand.

One basic exploitation of flexible tariffs is through Integrated tickets. Nowadays, mobility service providers have **multiple options to charge the user** (e.g., by areas—dividing the areas; by type of transportation—applying different charges; by distance travelled—pay per km; and by time spent travelling—pay per min). Moreover, there are **different payment methods** (e.g. Tickets, Smart Cards, Credit Cards, Apple Wallet, NFC devices, etc.) and **different ways to charge the user** (e.g., pay as you go, before starting or when the user finishes). Due to this non-standardized process, integrated tickets and smart cards will be efficient ways to pave the way towards interoperable public transport between cities, regions and countries, thus making mobility easier for users.

One example is the evolution of 'Oyster'[7] in London, a smartcard which can hold pay as you go credit, travel card and bus & tram pass season tickets. Passengers can use an Oyster card to travel on buses, Tube, tram, DLR, London Overground, TfL Rail, Emirates Air Line, River Bus services and most National Rail services in London. This card can also add discounts depending on the mobility pattern of the user.

Another example is 'T-Mobilitat'[8], a new transport system that will enable passengers in Barcelona to make an individualised calculation of the price of public transport. The new system will entitle frequent users to discounts and will allow for prices to be reduced to discourage the use of private vehicles in the event of episodes of atmospheric pollution. Through a personalised card, users will be able to pre-pay, post-pay, make top-ups online and pay for their trips via a mobile phone. Moreover, mobility data collected by the system will enable planning and management of the public transport network to be improved.

RATP[9] with Navigo smartcard is an example deployed in Paris, which allows passengers unlimited use of the public transport networks in the zones selected: metro, RER, bus, tramway and train.

Nowadays, the number of cities offering different innovative services (such as in Amsterdam, Berlin, etc.) is exponentially growing.

To conclude, personalized services with flexible tariffs and dynamic pricing strategies demonstrate care about who the customer is and what their needs are. Mobility as a Service (MaaS) endeavours to get to know users' habits and propose better options for their needs based on their specific preferences in order to enhance their travel and make mobility more comfortable. To coordinate and

[7] https://tfl.gov.uk/fares-and-payments/oyster/what-is-oyster?intcmp=1685
[8] https://web.gencat.cat/en/actualitat/reportatges/t-mobilitat/index.html
[9] https://www.ratp.fr/en/titres-et-tarifs

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cooperate between public and private business (e.g. sharing data, providing multi-modal services with private and public services, etc.) and personalize real-time services will be the key to improving mobility systems.

4.4 Identification of challenges and elements affecting equity and inclusivity in mobility and transport services among different user segments (UNIABDN (R), RUPPRECHT (C))

While the provision of transport services generally presents challenges, these may be heightened for services directly aimed at vulnerable user segments or in currently underserved areas. Users with special needs, such as those identified in section 2.4 above, may be limited as to their mobility options, and addressing these limitations often requires careful attention to the policies, resources, and services that enable the planning and design of transport services. In this section, we review some of these challenges, and how they may impact upon different user segments.

4.4.1 Instability and inconsistency in policies, practice and assigned resources

Considerations of social equity have increasingly been included in transport policy, with the move towards 'sustainable mobility', characterised as mobility that addresses economic, social, and environmental dimensions, a frequently cited trend. In the 2017 European Commission report 'European Urban Mobility: Policy Context', they state: "European cities face the challenge of how to enhance mobility, ensure accessibility, and create high quality and efficient transport systems while at the same time reducing congestion, pollution and accidents." Effectively and equitably meeting these needs is one of the key challenges currently facing European transport interests, particularly given the financial constraints currently being faced by many areas. Highlighting this is the following statement from the report 'Social Inclusion in EU Public Transport':

> *For a long time the social dimension of public transport has received relatively little attention in the academic literature and policy-making. In the near future the social and transport challenges represented by demographic ageing, poverty, migration and geographical disadvantage will increase. The social role of transport needs to be incorporated into transport policies, with closer attention to the specific mobility needs of the most vulnerable user groups. Improved accessibility for the elderly and people with reduced mobility, as well as higher quality services and lower fares for all, must be considered, together with improved efficiency to keep public transport financially viable* (Lodovici and Torchio, 2015).

The inclusion of social equity in current policy is often addressed in a fragmented or piecemeal fashion. Tenets related to the Common Transport Policy that are applicable to social equity include the following:

- Urban mobility: the 2009 Action Plan on Urban Mobility addresses mobility rights of those with reduced mobility.

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- Directive 2010/40/EU (framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport Text with EEA relevance) calls for adoption of specifications, establishment of standards, and selection and development of ITS applications and services with the aim of greater equality of access for vulnerable users.
- The EP Citizen's Agora on Crisis and Poverties of 2011 highlighted the fact that social inclusion policies should meet the mobility and accessibility needs of people in situations of precariousness (Lodovici and Torchio, 2015).

While these policies are useful for encouraging practices that may contribute to equitable mobility, they do not demonstrate full recognition of coordinated approaches to addressing underlying needs. As stated by Lucas and Musso (2014), "…the main thrust of transport policy to date (where this exists) has been on providing supplementary public transport services to transport disadvantaged groups and communities so that they can more easily and affordably access key activities such as work, health visits and education. However, at best this goal has remained a marginal aspect of transport policies". The overarching finding is that while there is recognition on a number of fronts that social equity and transport are closely related to one another, the policy environment for addressing this intermingling is thus far underserved.

Much the same is true for funding sources, which are also often limited with respect to applications for projects specifically aimed at meeting social equity aims through transport applications. In the 2016 report *EU financial support to sustainable urban mobility and to the use of alternative fuels in EU urban areas*, a number of EU financial tools were identified that have applications within the realm of sustainable and equitable mobility, including: The European Regional Development Fund (ERDF); The Cohesion Fund (CF); The LIFE programme; The 5th, 6th and 7th Framework Programmes; TEN-T programme; and EIB tools (Tomassini et al., 2016). While European funding is of benefit to those areas where it is received, the need to more fully integrate funding for services that will benefit vulnerable populations is pressing.

4.4.2 Prioritisation of and capacity to model peak-hour journeys to work and school compared to other times and travel purposes

A further challenge to address is that transport has traditionally been modelled and planned to be most reflective of 'peak-hour' travel – i.e. roughly between the hours of 06:30 and 09:30 and 16:00 and 19:00 on weekdays. A related consideration is that the main focus has often been on journeys to work and for education purposes, which may fail to address the changing nature of travel. According to Huang and Levinson (2015), in the US "Non-work destinations, including a spectrum of trip purposes: social, recreational, shop, family, personal, school, and church activities, comprise approximately 90% of trips." Similar patterns are emerging across Europe, as the complexity of our travel increases. This, combined with improved data collection methods across all trips, has highlighted the importance of increasingly considering other destinations and travel demands in our modelling efforts – particularly as we begin to move towards more data-rich activity- and agent-based models. Shifting prioritisation may also provide for a more robust description of the travel behaviours of those who may previously been under-accounted for. Lucas et al. (2016), for example, in a study of socially disadvantaged populations in Merseyside (UK) found that "…income effects and

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other indices of social disadvantage have a significant influence on travel behaviours (and vice versa)." Such factors as irregular work hours, medical appointments, and limitations of service may make the travel patterns of vulnerable user groups prone to misinterpretation, while lack of available quality data on these travellers may compound the effects. While some efforts have been made to address such concerns (through, for example, oversampling of commonly under-represented populations in travel surveys, or undertaking specific modelling efforts to address irregular travel needs), again, the underlying issue is the need to more consistently include considerations of social equity in baseline modelling efforts.

4.4.3 Political and agency preference for large capital investment projects compared to diffuse operational expenditure

While some capital investment in transport infrastructure projects have been shown to have beneficial impacts upon local economies (for example, certain types of roadways when coupled with quality government structures (Crescenzi et al., 2016)), these impacts are not always seen across all segments of society. Nonetheless, funding for capital investment projects are often seen as more attractive to local, regional, and national governments than are ongoing maintenance work. However, such investments may be more cost-effective over the long term. As noted in a report sent to the Transport Council (2015), "A wide range of financing options at EU-level for transport infrastructure exists, including the European Structural and Investment Funds (ESI Funds), European Fund for Strategic Investment (EFSI) and the Connecting Europe Facility (CEF), including related financial instruments, to complement Member States funding resources." The opportunities afforded by such funding resources provide useful impetus for the development of capital expenditures on new roadways and expanded public transport systems; however, funding for long-term operational and maintenance expenditures may be in shorter supply. As most operational, as opposed to construction, costs are expected to be covered through the operating entity via farebox revenue or local tax revenues, some local authorities or transport service providers may be more inclined to implement new services or construct new infrastructure rather than invest in current services, particularly if cost-benefit analysis indicates greater benefit from the new investment (particularly if considering benefits from the point of view of employment or development benefits). Such approaches may hinder the ongoing provision of adequate services for disadvantaged populations, as services that support the needs of these populations may not be the most politically advantageous.

4.4.4 Preference for advanced technologies and elimination of human actors

A final consideration that may challenge the provision of services to vulnerable user groups is the recent shift of provision of supporting transport services from human actors to technology-enabled methods. As noted in section 2.5, the benefits of technology are being widely seen across the transport sector, with useful innovations in terms of scheduling of transport services, access to real-time and on-demand information, improvements in payment methods, and emerging models of service provision. Such benefits, however, may come at a cost. With new investments in technologically-enabled models of service provision, it may become increasingly difficult to interact with a human along the transport chain. Such transitions may prove detrimental to persons with limited understanding of or access to digital technologies, as accessing information at different

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points of the journey may be difficult with reductions in staff or inadequate attention to 'traditional' resources (such as updated paper timetables). Additionally, such shifts as the increasing movement towards mobile device-based ticketing or online purchase may hinder the casual or infrequent public transport rider, as on-board cash payments become increasingly difficult or entail a financial disincentive. The replacement of human actors by advanced technologies is, in many ways, beneficial; however, the potential negative ramifications for some sectors of society may be substantial.

4.5 Positioning the Pilot Labs in the framework of prioritized areas and target user groups (MEM (R), UNIABDN (C))

One of the main objectives of INCLUSION is to achieve concrete validation of selected innovations and novel concepts found in WP2 and WP3 in six Pilot Labs (PLs): Rhein-Sieg region (DE), Flanders region (BE), Budapest urban area (HU), Florence metropolitan area (IT), Barcelona peri-urban area and neighbouring conurbation (ES) and Cairngorms National Park rural area (UK).

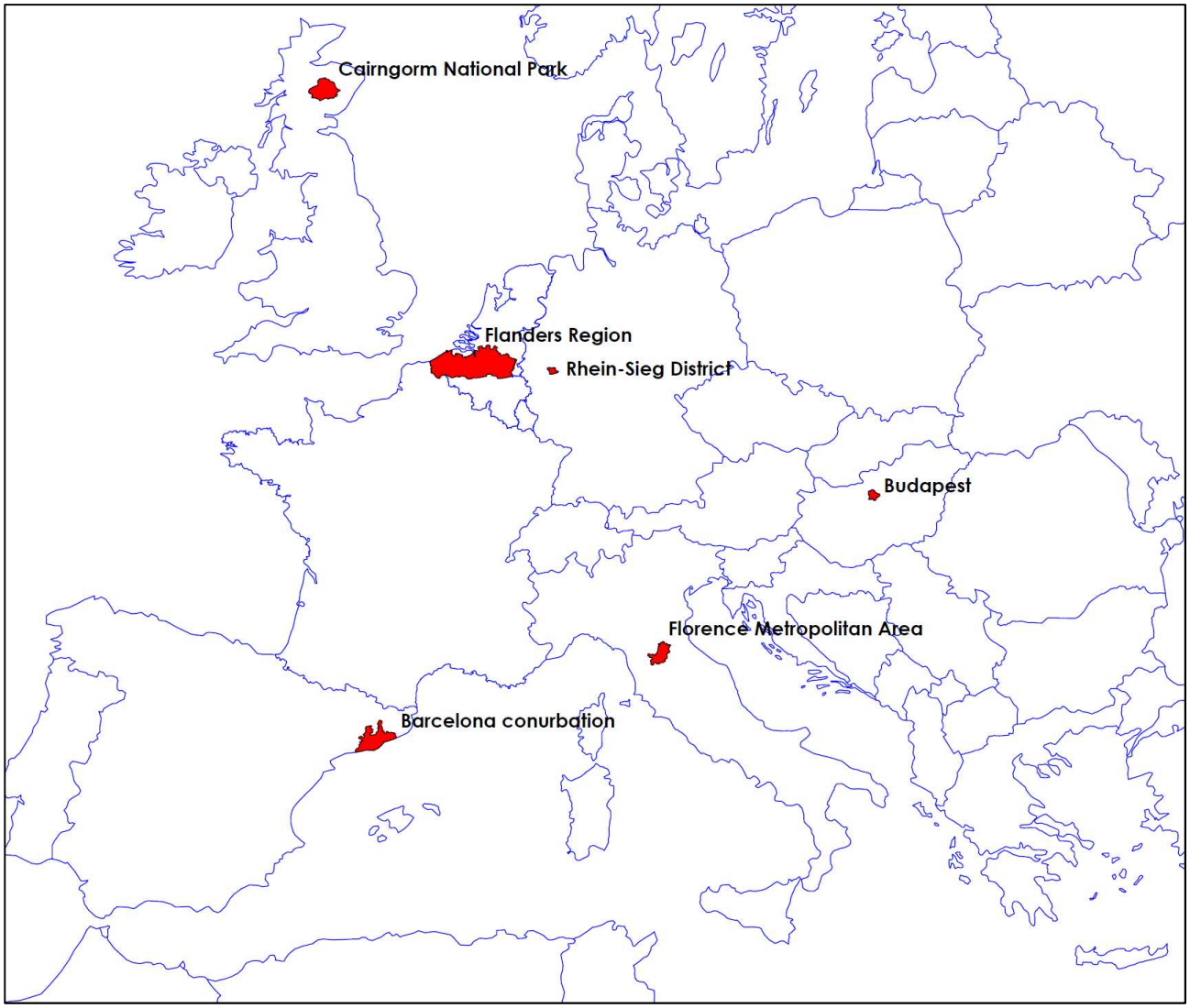

Figure 4.2: INCLUSION Pilot Labs

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In parallel to the research activities carried out in tasks 1.1 and 1.2, the WP1 partners invited the Pilot Labs partners to complete a questionnaire with the following aims:

- To involve the pilot labs in the project activities and INCLUSION approach at the start of the project;
- To ensure effective preparation and background for WP4 pilot activities
- To help focus WPs 1, 2 and 3 so they give relevant and value-adding materials to the Pilot Labs.

The questionnaire includes two parts: Part A – Overview and needs analysis, and PART B – Identification of possible solutions to be demonstrated in the Pilot Labs. The questionnaire has been submitted to the Pilot partners in order to:

- Classify all six Pilot Labs in a common framework
- Analyse the local context of the Pilot Labs
- Identify the main changes involved in each Pilot Lab (service, target groups, processes, systems, pricing, funding, etc.);
- Through preliminary gap analysis, identify likely requirements for each Pilot Lab in terms of approach, good practice, ITS/ICT, operations methods, understanding of user needs, customer outreach, processes, administration, integration, etc.;
- Ensure that the work in WPs 1, 2 and 3 has as a primary focus to identify user needs (WP1), technologies (WP2) and practice/outcomes (WP3) that are relevant to and usable by the Pilot Labs;
- Ensure that the Pilot Labs are fully engaged with WP 1, 2 and 3 activities and incorporate the most relevant material into their individual Pilot Lab design and deployment;
- Ensure that all Pilot Labs have preliminary concepts by Month 4 so that preparatory actions with longer lead-times, authorizations, approvals, negotiations etc., can be initiated now and not become delay factors when WP4 fully mobilises in Year 2.

The questionnaire is attached to this deliverable.

All Pilot Lab leaders have completed the questionnaire providing information (more or less detailed) about the Pilot Labs. In this section, the results of Part A of the questionnaires submitted to the Pilot Labs are outlined for each site.

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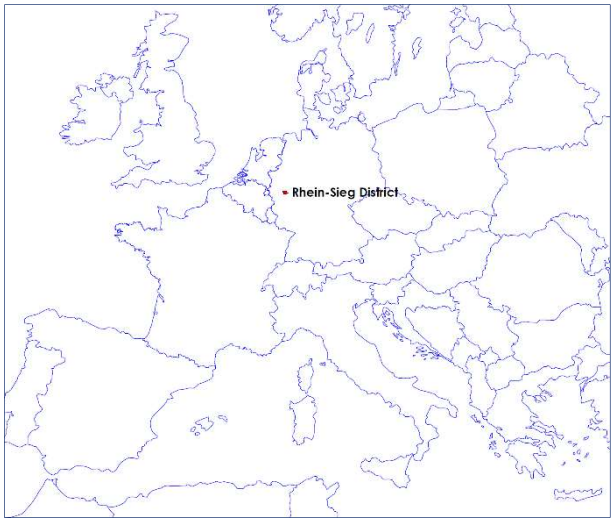
GERMANY
DISTRICT RHEIN-SIEG



The German Pilot is composed by two pilot sites: Hennef Im Siegbogen and Eitorf.

Hennef Im Siegbogen is a finished developement area in Hennef, next to the cities Bonn and Cologne in the Rhine-Sieg Region. The Rhine-Sieg area is located in the west of Germany and the Dutch or Belgian coast can be reached in a few hours by car or train. A lot of families with younger children in the Rhine-Sieg Region are looking for affordable housing space. Hennef Im Siegbogen has a good access to both public and private transport. There is access to schools and good shopping facilities. The environs are local recreation areas and invites to wander or cycle.

Eitorf is a city where a developement area is in construction, next to Hennef. Eitorf has access to both public and private transport and there is access to schools. The environs are local recreation areas and invites to wander or cycle.

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Site description (1): Hennef Im Siegbogen

- Area covered: < 5 Km2
- Population density: > 500 inhab./Km2
- Target group: Family with children
- Population of the target group: between 500 and 2000 users

Site description (2): Eitorf

- Area covered: < 5 Km2
- Population density: between 200 and 500 inhab./Km2
- Target group: Family with children
- Population of the target group: between 100 and 500 users

Characteristics and trip motivation of the target users

Target users, in both sites, are families with younger children who travel for work, education purpose, shopping or for social reason.

The children visit the kindergarten or the basic primary school. Both parents got jobs (thereof mostly one part time job even if the children are younger). Car ownership is between one and two cars per household. Access to private transport is high. Access to public transport is low, modal split is dominated by the use of the own car.

In Hennef and in Eitorf the modal split and the direction of the trips are as follow:

Hennef	Eitorf
Modal split	Modal split
- Driver of own car: 48% - Co-Driver car: 16% - Public Transport: 9%	- Driver of own car: 50% - Co-Driver car: 15% - Public Transport: 16%

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- Bike: 7%
- Going by feet: 20%

Aim of the trips:

- Work: 31% municipality, 8% Bonn, 40% district, 21% others
- Shopping, Leisure: 62% municipality, 5% Bonn, 23% district, 9% oth.

- Bike: 1%
- Going by feet: 18%

Aim of the trips:

- Work: 32% municipality, 30% Bonn, 19% district, 19% others
- Shopping, Leisure: 67% municip., 2% Bonn, 25% district, 5% oth.

Target user needs

Target user needs are the same for the two sites.

The young families with children need mobility solutions for their daily multi-chain-trips. These trips include accompanying the children to kindergarten and/or basic primary school, going to the workplace, buying groceries, and organizing the daily needs. At noon or at afternoon all activities are done in reverse order. Additionally, during the afternoon and/or evening there are leisure time activities at different places which must be reached. The combination of these daily trips need a combination of mobility offers to the target users to implement without large infrastructural solutions but low-cost ideas.

Mobility demand

Bringing children from new housing estate to kindergarten or basic primary school. Going to own working place after bringing children/going to main station to drive to working place in another city. Bringing the children to friends or sports club. This means three to four trips per day. But, as written before, more important is the possibility to combine these trips without using the car (multi-chain-trips). The length of all daily trips is 43 kilometres in sum.

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Mobility services operated in the sites

Hennef

Conventional Public Transport:

- Deutsche Bahn Regio AG (trains), S 12 & S 19
  Monday – Friday together three times/hour to Cologne (and back) from 5am to 12 pm
  Saturday two times/hour to Cologne (and back) from 5am to 12pm
  Sunday two times/hour to Cologne (and back) from 6am to 12 pm
  DB Regio AG is part of the Deutsche Bahn Group.
- Rhein-Sieg Verkehrsgesellschaft (buses), Line 532
  Monday – Friday one time/per hour from 5am to 8pm
  Saturday one time every second hour from 8am to 8pm
  Sunday one time every second hour from 10am to 8pm
  Rhein-Sieg Verkehrsgesellschaft mbh is a private limited company (Ltd.) – owner is the Rhine-Sieg district
  Fares are unique in the tariff of VRS

Taxis: Private Taxi companies

Eitorf

Conventional Public Transport:

- Deutsche Bahn (Regional Express, suburban train)
  Monday – Friday 5am to 01am three trains/hour
  Saturday/Sunday 5am to 02 am two trains/hour (partly three)
- Rhein-Sieg Verkehrsgesellschaft (buses), Lines 533, 564, 570, 571, 573, 579
  Monday – Friday one time/per hour from 6am to 9pm
  Saturday/Sunday every second hour from 8am to 8/9pm
  During Off-peak hours partly demand bus (TaxiBus) is in use
- Rhein-Sieg Verkehrsgesellschaft mbh is a private limited company (Ltd.) – owner is the Rhine-Sieg district

  Fares are unique in the tariff of VRS
- Taxis: Private Taxi company

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Site description (1): Hennef Im Siegbogen

- Area covered: < 5 Km2
- Population density: > 500 inhab./Km2
- Target group: Family with children
- Population of the target group: between 500 and 2000 users

Site description (2): Neunkirchen-Seelscheid Wolperath

- Area covered: < 5 Km2
- Population density: between 200 and 500 inhab./Km2
- Target group: Family with children
- Population of the target group: between 100 and 500 users

Characteristics and trip motivation of the target users

Target users, in both sites, are families with younger children who travel for work, education purpose, shopping or for social reason.

The children visit the kindergarten or the basic primary school. Both parents got jobs (thereof mostly one part time job even if the children are younger). Car ownership is between one and two cars per household. Access to private transport is high. Access to public transport is low, modal split is dominated by the use of the own car.

In Hennef and in Neunkirchen-Seelscheid, the modal split and the direction of the trips are as follow:

Hennef	Neunkirchen-Seelscheid
Modal split	Modal split
- Driver of own car: 48% - Co-Driver car: 16% - Public Transport: 9%	- Driver of own car: 51% - Co-Driver car: 17% - Public Transport: 7%

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- Bike: 7%
- Going by feet: 20%

Aim of the trips:

- Work: 31% municipality, 8% Bonn, 40% district, 21% others
- Shopping, Leisure: 62% municipality, 5% Bonn, 23% district, 9% oth.

- Bike: 1%
- Going by feet: 25%

Aim of the trips:

- Work: 37% municipality, 12% Bonn, 26% district, 26% others
- Shopping, Leisure: 55% municip., 3% Bonn, 29% district, 14% oth.

Target user needs

Target user needs are the same for the two sites.

The young families with children need mobility solutions for their daily multi-chain-trips. These trips include accompanying the children to kindergarten and/or basic primary school, going to the workplace, buying groceries, and organizing the daily needs. At noon or at afternoon all activities are done in reverse order. Additionally, during the afternoon and/or evening there are leisure time activities at different places which must be reached. The combination of these daily trips need a combination of mobility offers to the target users to implement without large infrastructural solutions but low-cost ideas.

Mobility demand

Bringing children from new housing estate to kindergarten or basic primary school. Going to own working place after bringing children/going to main station to drive to working place in another city. Bringing the children to friends or sports club. This means three to four trips per day. But, as written before, more important is the possibility to combine these trips without using the car (multi-chain-trips). The length of all daily trips is 43 kilometres in sum.

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Mobility services operated in the sites

Hennef

Conventional Public Transport:

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  Saturday two times/hour to Cologne (and back) from 5am to 12pm
  Sunday two times/hour to Cologne (and back) from 6am to 12 pm
  DB Regio AG is part of the Deutsche Bahn Group.
- Rhein-Sieg Verkehrsgesellschaft (buses), Line 532
  Monday – Friday one time/per hour from 5am to 8pm
  Saturday one time every second hour from 8am to 8pm
  Sunday one time every second hour from 10am to 8pm
  Rhein-Sieg Verkehrsgesellschaft mbh is a private limited company (Ltd.) – owner is the Rhine-Sieg district
  Fares are unique in the tariff of VRS

Taxis: Private Taxi companies

Neunkirchen-Seelscheid

Conventional Public Transport:

- Rhein-Sieg Verkehrsgesellschaft (buses), Line 578
  Monday – Friday one time/per hour from 6am to 9pm
  Saturday one time every second hour from 8am to 10pm
  Sunday one time every second hour from 10am to 10pm
  Rhein-Sieg Verkehrsgesellschaft mbh is a private limited company (Ltd.) – owner is the Rhine-Sieg district
  Fares are unique in the tariff of VRS

Taxis: Private Taxi company

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ITALY
FLORENCE METROPOLITAN AREA

The Pilot site is the Florence Metropolitan Area characterized by:

- 794 km2
- 651 000 inhabitants.

The site is characterized by a tram, bus and train transport system. In particular, there are 10 railway stations that play a very important role thanks to a good rail network.

The urban transport network offer is typical urban service with high/medium frequency lines.

The Florence Pilot involves two existing transport services: "Nottetempo", a Flexible Transport Services, and two lines (30 and 35) of the conventional PT services.

In particular referring to "Nottetempo", the involved area is mainly the south and east part of metropolitan area, while referring to the traditional line 30 and 35, the involved area is mainly from the central railway station to the north of Florence.

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Site description (1), related to "Nottetempo" Service

- Area covered: between 80 and 200 Km2
- Population density: > 500 inhab./Km2
- Target group: Young, Immigrant, Night workers
- Population of the target group: between 50 000 and 100 000 users

Site description (2): related to PT conventional service

- Area covered: between 40 and 80 Km2
- Population density: > 500 inhab./Km2
- Target group: Young, Immigrant, Low income
- Population of the target group: between 20 000 and 50 000 users

Characteristics and trip motivation of the target users

For what about the target users of the "Nottetempo" service, they have been identified in:

- night workers who finish working late when the traditional public transport is no longer active
- Immigrants without a car who need a transport also during the night
- Young without car's license or people who want go out without car
- Users who prefer not to take the car in the city centre

For what about the users of the conventional PT lines (lines 30 and 35), the most of target users are immigrants or low-income residents who, due to the lack of private car, need a transport with an economical fare to reach the workplace and educational centres.

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Target user needs

The needs of the target users of "Nottetempo" service are the followings:

- A transport covering almost the totally of the metropolitan area of Florence in order to satisfy most of the mobility demand
- The possibility to have an integrated payment system in the App.
- An economic fare: the current fare can be too expensive especially in the case of more users group together, for whom the choice of taxy could result more convenient
- The possibility to have interactive information services (ie Ataf 2.0 App) and the possibility to book the service through App.

The needs of the target users of conventional PT lines 30 and 35 are:

- A transport more frequent and characterized by an economical fare
- An improvement of the public transport accessibility of the target users in suburban and peripheral area of Florence
- An improvement of the public transport service through a possible involvement of the voluntary associations which can better underline their needs.

Mobility demand

"Nottetempo" service

The current mobility demand is concentrated from the centre to the peripheral areas served in the south and east part of the Florence metropolitan Area.

In the Area 1 (Scandicci) the most common trips are towards tramway stop, because Tram line 1 is operated in this area until late night.

The most of the trips are from work to home because usually the trips from home to work are done when traditional lines are still active.

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The current mobility demand is more concentrated in the warm season rather than in cold seasons and the most of the trips are on Friday and on Saturday, instead on Monday and on Tuesday the booking of the service is minimum.

The medium length of the trip for single user is about 7Km/user and the medium number of users in a night is about 45 passengers.

From a study of the three areas served by Nottetempo it's possible underline that the largest number of requests are in the area 1 (Scandicci) (28-30 users) because of the tramway service; the Gavinana sector presents a lower number of requests (22-25 users).

Conventional PT lines 30 and 35

The direction of the journey is usually from the central railway station to the north of Florence and the return trip is usually in the opposite direction. Probably some immigrants go to social centers during the day, especially at the lunch time.

Since they are mainly travelling to work, they are concentrated in hours corresponding to the entry and exit from work, and they are probably more concentrated from Monday to Friday and few in the weekend.

Mobility services operated in the sites

The mobility services operating in Florence are the following:

- Taxis are operated by 2 company So.co.ta and Co.ta.fi which cover all the Florence metropolitan area. Recently 70 licences were granted for fully electric vehicles
- Special services for students, operates by Ataf with 4 buses for a minimum of 50 passengers. The cost of the trip corresponds to the fare of a single ticket for each passenger.
- Car sharing: there are 2 operators Car2go with a fleet of 250 vehicles and Enjoy with 73 vehicles.

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- Bike sharing: there are 2 operators of dockless bike sharing: Mobike with 4000 bikes and GoBee bike with 500 bikes at the moment to be extended to 4000. With this dockless bike sharing is the possibility to pick up and release the bike wherever you are through a mobile app.
- Conventional Public Transport: operated by Busitalia through its controlled company Ataf Gestioni in urban district. Ataf manages the Local Public Transport with a fleet of 360 buses, 41 lines and 15.5 milion bus km per year < credo che facciano complessivamente 100 Ml km anno. The service structure is the typical Urban service with high and medium frequency lines.
- DRTs: Nottetempo is a DRT service active during the night from 10.00 to 3.00. The reservation is made by calling a phone number. The service is operated by Ataf Gestioni, through seven buses that operated on the south and east part of metropolitan area

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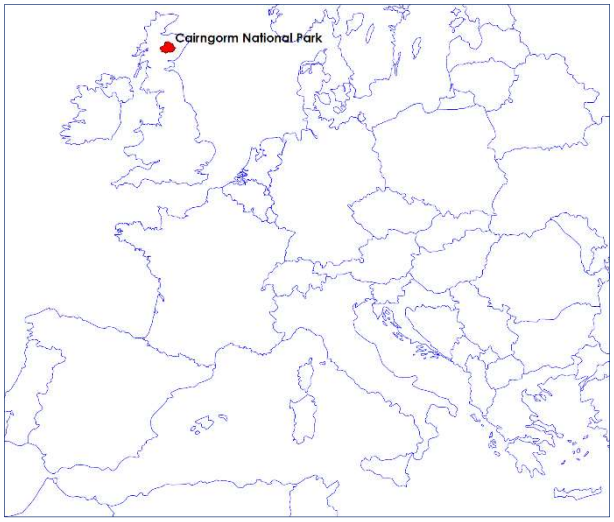
UK
CAIRNGORM NATIONAL PARK



The Cairngorms National Park is the UK's largest National Park and offers activities such as watersports, snowsports, wildlife watching, walking and cycling. Statistics show 1.6 million visitors to the area, with Inverness its closest city at approximately 30 miles from the Park. The area covers parts of Aberdeenshire, Moray, Highland, Angus and Perth and Kinross, creating an interesting test site covering multiple local authorities. The pilot aims to improve the figure that only 3% of visitors use public transport for mobility. An appropriate location will be selected, with one suggestion being a project focussing on the Aviemore area.

Site description

- Area covered: > 2000 Km2
- Population density: < 10 inhab./Km2
- Target group: Young, Elderly, Family with children, Low income, Tourist
- Population of the target group: between 5 000 and 20 000 users

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Characteristics and trip motivation of the target users

The target users for the pilot are both residents and tourists. Several vulnerable groups have been identified: elderly people / persons of reduced mobility, residents who suffer from fuel poverty due to high rural fuel costs, young people who face the challenge of not having access to their own mobility solution, and inhabitants in dispersed settlements. People may travel for work, education purpose, tourism, social reason or leisure.

Target user needs

Improved accessibility to public transport for vulnerable groups of residents who suffer most greatly from transport poverty (elderly and young people) and tourists visiting the area.

Mobility demand

Traffic volumes in the peak area during school holidays and seasonal activities such as skiing make small, unclassified roads (traditionally used for cycling and walking routes) busy and dangerous. The traffic has a constant level of HGVs passing through the main corridor through the CNPA due to the whisky industry and through connectivity to other parts of Scotland, thus the ability to offer connected mobility will assist the current statistic of 90% of visitors utilising the car to move compared to 3% by public transport and 7% by cycling.

Mobility services operated in the sites

- Conventional Public Transport

  The main provider of public bus services in the area is Stagecoach North Scotland who operate the following bus routes to, from and within the area:

  Service 31 Aviemore Town

  Service 34 Aviemore – Carrbridge

  Service 36 Aviemore – Grantown on Spey

  Service 38 Aviemore – Kingussie

  Service 39 Aviemore – Dalwhinnie

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Service M91 Aviemore - Newtownmore

Service M91 Aviemore – Inverness

Service 38 Aviemore – Kingussie

Other important bus services are:

Megabus.com who operate:

M90 – Inverness – Aviemore – Perth (for onward travel to Glasgow) – Edinburgh

Scottish Citylink who operate:

Gold Service G10 – Inverness – Aviemore – Glasgow

Gold Service G90 – Inverness – Aviemore – Perth – Edinburgh

Rail services to Inverness, Glasgow, Edinburgh, London and intermediate stations serve Aviemore. The operators are:

ScotRail – www.scotrail.co.uk

Virgin East Coast – www.virgintrainseastcoast.com

Caledonian Sleeper – www.sleeper.scot

- Taxis – www.taxisaviemore.com and www.aviemoretaxis.com
- Special services (e.g. for tourist, for children etc.) – various commercially operated tour services for tourist travel operate from location outside the CNPA area and encompass the park in the tours offered**.**
- Bike/car sharing:

  Voluntary car services – www.ct4u.co.uk is the Badenoch and Strathspey Transport Company who offer a range of services including a Community Car Scheme. This service is provided by Volunteer drivers using their own vehicles to get people out to vital life and health services, increasing their social interaction. To become eligible for the scheme, you must have no transport of your own and be unable to access public transport for whatever reason

  When a client registers with the scheme, they receive an ID number. Journeys can be anything from visiting a friend, shopping, attending the doctor, to the bus/train station or just going for coffee. Payment is on a minimum charge or mileage rate basis.

  Volunteer Drivers become members of the Protecting Vulnerable Groups (PVG) Scheme, which involves a search of criminal records. They are offered full training to carry out their

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required duties. Drivers are paid a mileage rate which is non-profit making and under car sharing legislation, so should not affect their car insurance.

Car sharing services have been established by HITRANS and can be accessed at https://liftshare.com/uk/community/hitravel

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BELGIUM
FLANDERS REGION

The Flanders region is characterized with its spatial planning making it difficult to foresee fluent public transport. There is a lot of car dependency in Flanders which causes daily traffic jams. The pilot will focus on improving accessibility to PT and sustainable mobility services in Flanders, enhancing the provision of innovative and cost-effective combined transport scheme based on the integration of conventional bus PT (as a backbone) with car-pooling, shared and on-demand services (for the last mile and door-to-door trips).

Site description

- Area covered: > 2000 Km2
- Population density: > 500 inhab./Km2
- Target group: Elderly, Disabled, Low income.
- Population of the target group: between 20 000 and 50 000 users

Characteristics and trip motivation of the target users

The target users of Flanders Region are people with reduced mobility and/or low-income people; in particular, they are mainly elderly people and disable people without a private car or a drive license who travel only for social reason. In addition, usually they cannot afford a taxi

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Target user needs

The target users need to find a solution to get to their social activities within an affordable and economic way.

Mobility demand

The demand is limited to social activities. At the moment, the trips requested by the users of "Minder Mobielen Centrales" members (a volunteer transport service operating in Flanders) are often for family visits, food, visits to hairdressers, medical or administrative visits to the town hall

Mobility services operated in the sites

- Conventional Public Transport

  The main provider of public bus and tram services is De Lijn Public Transport Company. Key figures of De Lijn:

  Number of passengers

  519 million

  Kilometers covered per province

Province	Tram	Bus
Antwerp	10 858 890	47 335 778
East Flanders	2 986 550	36 450 676
Flemish Brabant	/	47 532 721
Limburg	/	30 583 497
West Flanders	2 952 783	28 102 655
Total	16 798 223	190 005 327

- The main provider of rail services in Flanders and Belgium is the NMBS Company. Both the NMBS and De Lijn are government organisations.
- Bike sharing: Blue-Bike, Velo (Antwerp), Villo, Cloud bike

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- Car sharing: Cost-sharing: Dégage and Cozycar. Peer-to-peer car sharing: Caramigo, Drivy and Tapazz. Station based car sharing providers: Cambio and Stapp.in. Free floating car sharing services: Partago, Bolides, Poppy and Ecomobiliteit.
- Carpooling: www.carpool.be www.blablacar.be www.karzoo.be
- Taxis: a lot different taxi service provider http://taxis.vlaanderen/

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SPAIN
BARCELONA CONURBATION

ICT methods and tools will be applied in the peri-urban area of the Barcelona Metropolitan Region (BMR) in order to investigate the target groups transport demand through information mining from Social Networks and organise transport services that adapt dynamically over time to meet the identified mobility needs and demand and improve transport accessibility. In Barcelona, Transit authorities prioritize infrastructure investment in urban centres, which are more densely populated and amenable to public transportation with frequent, regular stops. There is a mounting demand for transport services to, from and around peri-urban areas. PT authorities generally provide radial routes linking peripheries and the metropolitan centres. However, radial routes do not always meet the needs of citizens in outlying areas, as they are inflexible and often infrequent, forcing people to use cars. In the Inclusion target area, PT is essentially limited, basically set by regional train and bus services which are limited geographically and only during daytime.

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Site description

- Area covered: > 2000 Km2
- Population density: > 500 inhab./Km2
- Target group: Young, Low income
- Population of the target group: > 500 000 users

Characteristics and trip motivation of the target users

The target users of Barcelona Pilot Lab are occasional travellers – particularly young people- that can form spontaneously among like-minded people sharing common interests like e.g. travelling to common destinations such as concerts, football games, theme parks, nature excursions, etc.

This target group are regular commuters in peri-urban and urban areas with low traditional PT offer (based on analysis conducted by BusUp, these represents 74% of total transport market in the area).

Target user needs

The users need on-demand services from point A to point B because of the public transport limitations. They ask for safer, cheaper and more comfortable ways to travel, avoid taking private car. Parking limitations or non-alcohol consumption during leisure activities can also push for considering transport alternatives.

Mobility demand

The mobility demand for this target user group are occasional trips to go to events. Usually, these events are taken place during hours that PT is not frequent (i.e. during night).

Without the on-demand service proposed in this Living Lab, the target user group is used to either taking their own car (in the cases that this is possible) or not going to the festival.

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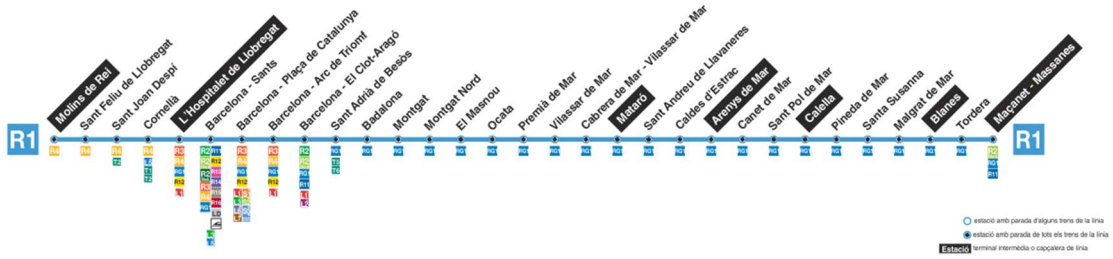
Mobility services operated in the sites

- Conventional Public Transport

  RENFE-Rodalies, Regional train services

  1 line (R1) From Barcelona to Massanet-Massanes

  Extent of the services: 100km from Molins de Rei to Massanet de la Selva.



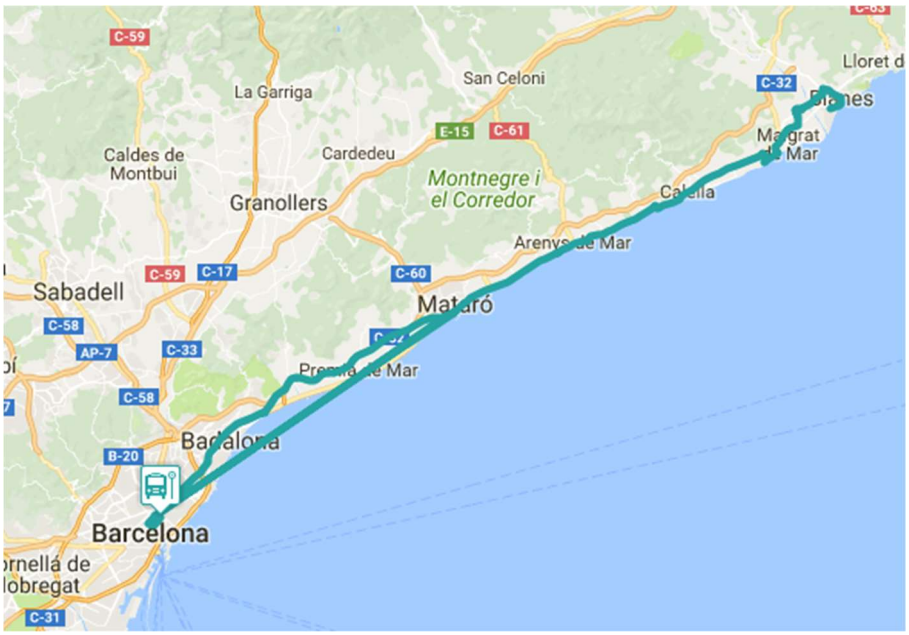
  Operational hours: from 4:50h to 00:07h on weekdays and from 6:04h to 00:55 on weekends

  Fares: One way ticket is 4,1 €

  Bus services are provided by Sagalés, operating as regular night bus

  One line (N82) from Barcelona to Pineda de Mar (stop in Canet de Mar);

  Extent of the services: 100km from Barcelona to Blanes.



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Operational hours: from 23:12h to 06:20h on weekdays and from 22:57h to 06:25 on weekends

Fares: One way ticket is 6,5 € and integrated ATM tickets are available

- Taxis: five local taxi drivers
- Shared taxis: available with near town
- Carpooling (BlaBlaCar)

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HUNGARY
BUDAPEST

Budapest is the capital city of Hungary. It has a population of 1.75 million inhabitants and it has an extensive public transport system. The targeted area is the track bound service area (metro and tram) of Budapest. Budapest has a 39 km long metro network on four lines and one of the greatest tram network in Europe. Tram 6 is the busiest tram line in the world with more than 400 000 passengers daily. The tram network has been extended in 2016. Providing equal transport services for all is key priority, however the metro and tram network in Budapest is not accessible for everyone currently.

Site description

- Area covered: between 200 and 500 Km2
- Population density: > 500 inhab./Km2
- Target group: Young, Elderly, Disabled, Tourist
- Population of the target group: > 500 000 users

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Characteristics and trip motivation of the target users

In the Budapest Pilot Lab, there will be two target group, at two different level and phase. Firstly, the Pilot aims to target staff of the public transport sector (drivers, ticket inspectors etc.). Secondly, to target the wide public (of public transport users).

Target user needs

Approximately 10-15% of all public transport users somehow are reduced in mobility (disabled, visually impaired, passengers with luggage, temporarily disabled people, people who do not speak the local language) they demand a more inclusive, fair and helpful environment.

Mobility demand

Based on 2017 household survey, on an average weekday 2,8 million trips appears on the metro and tram network. In terms of distance travelled in the city, this is 19% of all trips. The share of PT users has been stagnated for the recent years. During the pilot, BKK will work with all kind of people, regardless to the destination of the trips (home to work, home to service, etc.). Budapest is a monocentric city, therefore large amount of all trips has destination in the city centre on the Buda side. Average trip length on tram is 2.6 km while it is 4.3 on metro.

Mobility services operated in the sites

Budapest Transport Plc (hereinafter: BKV) is in charge of fixed rail public transport operations in Budapest. BKV operates 4 metro and 33 tram lines in the city. The company is owned by the Municipality of Budapest and it is controlled by BKK. Budapest has a 42 km long metro network on four lines and one of the greatest tram network in Europe. Line 2 is partly while 4 is completely access-free while stations of line 1 and 3 do not have step-free access. The tram network is 160 km long, while tram line 6 is the busiest tram line in the world with more than 400 000 passengers daily. The tram network has been extended in 2016. Tram service is partly access-free. All stations on line 4-6 are step-free and a reconstruction programme in 2016 provided several additional access-free station on the tram network.

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Providing equal transport services for all is key priority, however the metro and tram network in Budapest is not accessible for everyone currently.

Main characteristics of the metro and tram services are summarized by the following table:

Characteristics	**Metro**	**Tram**
Network length per mode (km)	41,7	161,3
Number of routes per mode	4,0	33,0
Number of stations or stops-network per mode	103,0	642,0
Number of carriages or units per mode	461,0	602,0
Number of operators per mode	1,0	1,0
Train-km (millions/year)	7,7	19,4
Places-km per mode (millions/year)	5218,5	4282,1
Boardings/year per mode (millions/year)	422,5	421,1
Passengers-km per mode (millions/year)	1830,0	1087,3
Average trip distance (km)	4,3	2,6
Commercial speed per mode (km/h)	23,9	14,3
Average age of the vehicles/trains per mode (years)	24,1	32,8
Stops covered with SMS/mobile real time information systems per mode (%)	100,0	100,0

5 CONCLUSION – Outcomes on Part A and Part B (- UNIABDN (R), MEM (C))

As noted in the Introduction, the aim of this deliverable was to conduct a thorough examination of 'prioritised area' characteristics in terms of geography and population demographics and socio-economics, and to use these to better understand the impacts such characteristics may have upon the transport services provided. We have identified some of the key overarching challenges impacting upon these areas, with closer examination of:

- Models of service provision (including fixed route and flexible services, as well as emerging models such as Mobility as a Service (MaaS);
- Requirements for information provision to serve all users, including vulnerable users, through both the medium (for example, paper-based timetables, as well as on-demand information enabled by technology) and the message (in particular, how different population segments may need information tailored to them to encourage behavioural change);
- The varying impacts that different geographies may have upon relevant models of service provision, with particular attention to characteristics of urbanity and rurality; and
- How these different characteristics interact to create a spectrum of places with specific mobility needs; in particular, how they may be demonstrated in the pilot labs.

It is anticipated that the outcomes of this Deliverable will be useful in setting the stage for further work; providing a helpful resource for considering the myriad of factors that may need to be considered when developing appropriate and comprehensive methods for serving vulnerable user groups from the sides of both transport supply and demand. While there is no simple solution to the challenges identified, it is hoped that by developing the grounds for deeper and more co-ordinated understanding we may contribute to the dialogue. Overall findings from the research, and the ways in which they relate to the candidate case study characteristics identified in Section 2.1, and which will contribute to INCLUSION Work Package 3, have been included as tables below. We do not intend that these tables should be taken as final assessments of suitability or concerns for various prioritised areas; rather, they are intended to be used as evidence-based general guidance for determining key areas of challenge or consideration in the provision of services.

Table 4.1 presents the potential suitability of transport service provision models across the suggested site characteristics identified in Section 2 above. Based on the literature reviewed throughout the report, considerations regarding characteristics of service areas and the likelihood that various models of fixed or flexible public transport would be appropriate to provide efficient and effective services have been ranked as 'High', 'Medium', or 'Low'. This table is intended to serve as a generalised starting point to feed into discussions of potential service characteristics to be explored in further work packages. It is acknowledged that there is some subjectivity in the ways in which rankings have been assigned, as the interaction of various site characteristics may

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make final assignment difficult; however, it does provide a structured way of considering how various site characteristics may work for or against certain types of services.

Table 4.2 is intended to provide an overview of the degree of challenge experienced in serving different age populations based on the preceding findings from the literature. Some physical characteristics (such as uneven or steep terrain) have been noted as particularly challenging for elderly persons or young families, while characteristics associated with, for example, access to jobs or other activities may be more challenging for both older and younger adults. Again, the rankings contain an element of subjectivity; however, to the extent possible they are designed to reflect findings detailed in the discussion above and aim to serve as guideposts towards areas of potential consideration in further case study development.

As with Table 4.2, Table 4.3 looks to identify the potential degree of challenge in serving vulnerable populations across the metrics of disability, income and sex. Of note here is that while an attempt has been made to identify challenges associated with each characteristic separately, the interactions between different characteristics (such as being both low-income and with a disability that impacts upon mobility) may cause challenges to be particularly difficult to address. Again, the intention of this table is to provide an initial assessment of areas of consideration that may be particularly relevant for the INCLUSION case study areas; although further exploration should not be limited by these ratings.

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		Fixed route			Flexible transport services	
		Longer distance routes	Regional routes	Local fixed routes	Flexible bus routes	Demand Responsive Transport
Rural/remote area	Deprived, hilly area in economic decline with an ageing population	Medium	High	Medium	High	High
	Geographically isolated area with a seasonal economy and declining population	Medium	High	Low	High	High
	Flat area with an increasing population and mixed or improving economy	Medium	Medium	Medium	High	High
	Accessible rural town with a growing young population and changing economy	Low	Medium	High	Medium	Medium
Peri-urban area	Traditionally deprived area in economic growth, with an increasing population	Medium	Medium	High	Medium	High
	Declining suburban area with ageing population	Medium	Medium	Medium	Medium	Low
	Accessible small town located in a hilly area with a stable population and mixed economy	Low	Medium	High	Medium	Medium
	Suburban area with increasing young population and stable economy	Low	High	High	Medium	High
Urban area	Declining urban area with decreasing employment and population loss	Low	Medium	High	Low	Low
	Stable urban area with mixed employment	Low	Medium	High	Low	Low
	Growing urban area with increasing population and employment opportunities	Low	Medium	High	Low	Low
	Urban area with declining population, stable employment, and growing peri-urban areas	Low	Low	High	Medium	Medium
	Very large urban area with stable employment and a growing population	Low	Low	High	Medium	Medium
	Large flat urban area with declining employment and population	Low	Low	High	Low	Low
	Urban area located in hilly area with stable employment and population	Low	Medium	High	High	Low

Table 5.1: Potential suitability of transport service provision

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		Age				
		Children	Students/ early workers	Working age	Mature working age	Elderly
Rural/remote area	Deprived, hilly area in economic decline with an ageing population	Low	Medium	High	High	High
	Geographically isolated area with a seasonal economy and declining population	Medium	Medium	High	High	High
	Flat area with an increasing population and mixed or improving economy	Low	High	High	High	Medium
	Accessible rural town with a growing young population and changing economy	High	High	High	High	Medium
Peri-urban area	Traditionally deprived area in economic growth, with an increasing population	High	High	High	High	High
	Declining suburban area with ageing population	Medium	Medium	High	High	High
	Accessible small town located in a hilly area with a stable population and mixed economy	Low	Low	Medium	Medium	Medium
	Suburban area with increasing young population and stable economy	High	High	High	High	Medium
Urban area	Declining urban area with decreasing employment and population loss	High	High	High	Medium	Medium
	Stable urban area with mixed employment	Medium	Medium	Medium	Low	Low
	Growing urban area with increasing population and employment opportunities	Medium	Medium	High	High	Low
	Urban area with declining population, stable employment, and growing peri-urban areas	High	High	High	Medium	Medium
	Very large urban area with stable employment and a growing population	High	Medium	High	High	Medium
	Large flat urban area with declining employment and population	Low	Medium	Medium	High	Medium
	Urban area located in hilly area with stable employment and population	Medium	Medium	Medium	Medium	High

Table 5.2: Potential challenges of serving vulnerable populations (Age)

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		Disability		Income			Sex	
		Yes	No	Low	Medium	High	Female	Male
Rural/remote area	Deprived, hilly area in economic decline with an ageing population	High	Low	High	Medium	Low	High	Medium
	Geographically isolated area with a seasonal economy and declining population	High	Low	High	Medium	Low	High	Low
	Flat area with an increasing population and mixed or improving economy	Medium	Low	Medium	Low	Low	Medium	Low
	Accessible rural town with a growing young population and changing economy	Medium	Low	Medium	Low	Low	Medium	Low
Peri-urban area	Traditionally deprived area in economic growth, with an increasing population	Medium	Low	High	High	Medium	Medium	Low
	Declining suburban area with ageing population	High	Medium	High	High	Low	High	Medium
	Accessible small town located in a hilly area with a stable population and mixed economy	High	Low	Medium	Low	Low	Medium	Low
	Suburban area with increasing young population and stable economy	Medium	Low	Medium	Low	Low	Medium	Low
Urban area	Declining urban area with decreasing employment and population loss	High	Medium	High	High	Medium	High	Medium
	Stable urban area with mixed employment	Medium	Low	Medium	Low	Low	Medium	Low
	Growing urban area with increasing population and employment opportunities	Medium	Low	Medium	Low	Low	Low	Low
	Urban area with declining population, stable employment, and growing peri-urban areas	High	Low	High	Medium	Low	Medium	Low
	Very large urban area with stable employment and a growing population	Medium	Low	Medium	Low	Low	Medium	Low
	Large flat urban area with declining employment and population	High	Medium	High	High	Medium	High	Low
	Urban area located in hilly area with stable employment and population	High	Low	Medium	Low	Low	Low	Low

Table 5.3: Potential challenges of serving vulnerable populations (Disability, Income, and Sex)

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7 INCLUSION consortium

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Annexe A: Survey Template for Pilot Labs

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PART A: Overview and needs analysis

1. Pilot overview		
1.1	Pilot lab	☐ Rhein-Sieg ☐ Florence Metropolitan Area ☐ Cairngorm National Park ☐ Flanders ☐ Barcelona conurbation ☐ Budapest
1.2	Leader Partner	
1.3	Others Partners involved	
2. Site description		
2.1	General description *(Short description: max. 100 words)*	*Please describe in general the main characteristic of the Pilot site*
2.2	Transport environment / Prioritized area typology	*To be filled after the classification of different transport environment made in WP1*
2.3	Predominant type of activity in the area *(it's possible to add other categories; more than one can be chosen)*	☐ Residential ☐ Tourism ☐ Business Park ☐ Agriculture and Livestock ☐ ……
2.4	Area covered (x Km^2)	☐ $x < 5$ Km^2 ☐ $5 < x < 10$ Km^2 ☐ $10 < x < 20$ Km^2 ☐ $20 < x < 40$ Km^2 ☐ $40 < x < 80$ Km^2 ☐ $80 < x < 200$ Km^2 ☐ $200 < x < 500$ Km^2 ☐ $500 < x < 1000$ Km^2 ☐ $1000 < x < 2000$ Km^2 ☐ $x > 2000$ Km^2

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2.5	Population density (*x* inhab. / Km^2)	☐ *x* < 10 inhab. / Km^2 ☐ 10 < *x* < 50 inhab. / Km^2 ☐ 50 < *x* < 100 inhab. / Km^2 ☐ 100 < *x* < 200 inhab. / Km^2 ☐ 200 < *x* < 500 inhab. / Km^2 ☐ *x* > 500 inhab. / Km^2
3. User requirements		
3.1	Target group *(it's possible to add other categories; more than one can be chosen)*	☐ Young ☐ Elderly ☐ Immigrant ☐ Disabled ☐ Family with children ☐ Low income ☐ Tourist ☐ …
3.2	Population of the target group in the prioritized/target area (*x* users)	☐ *x* < 100 users ☐ 100 < *x* < 500 users ☐ 500 < *x* < 2000 users ☐ 2000 < *x* < 5000 users ☐ 5000 < *x* < 20000 users ☐ 20000 < *x* < 50000 users ☐ 50000 < *x* < 100 000 users ☐ 100 000 < *x* < 500 000 users ☐ *x* > 500 000 users
3.3	Trip motivation (of target group) *(it's possible to add other categories; more than one can be chosen)*	☐ Work ☐ Education purpose ☐ Shopping ☐ Tourism ☐ Social reason ☐ Leisure ☐ ……
3.4	Target user characteristics *(Short description: max. 100 words)*	*Please describe in general the main characteristic of the Target users (taking into account also the car ownership, the access to private transport…)*

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3.5	Target user needs (max. 200 words)	*(Please describe the major needs of the target users)*
4. Mobility demand		
4.1	Please describe the current mobility demand of the target user group(s) *(max. 200 words)* *Trips per day, days of the week, time of the day of trips, length of the trips, modal split and its trend …* *Direction of the trip ("from inside out", "from out to inside", into a limited area…)* *Origin / Destination points (e.g. home to work, home to sport centre…)*	
5. Mobility service operated in the site		
5.1	*Please list and describe the **existing mobility/transport services** operated in the Pilot (max. 500 words)* *Name of the Operator, Type of operator (e.g. commercial, community transport, municipality/authority) number of lines/fleet dimensions, extent of the services in terms of coverage area (including maps, if possible), operational hours/days, fares and any concessions for target users…)* - *Conventional Public Transport*	

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	- *Taxis* - *Shared taxis* - *DRTs* - *Special services (e.g. for tourist, for children etc.)* - *Flexible Public Transport* - *Bike/car sharing* - *Voluntary car services* - *Sustainable "individual" mode / "soft" measures (e.g. personal bike, carpooling…)*	
5.2	Promotion and provision of useful information of each service (max. 100 words)	*Please describe what promotion, marketing, awareness raising, engagement takes place.*
5.3	Funding/business models related to the transport services (max. 100 words)	*Please describe the funding/business models which services currently operate under (where do services obtain their revenues from? Do they require or receive subsidies / grants to maintain the service provision? What are these subsidies/grants?)*

6. Technological & ITS background *(please list the ITS systems supporting the operation of services)*			
6.1	**Mobility Transport service**	**ITS** *(e.g. Real-time localization and*	**Service provided** *(please indicate the services in terms of info, payment tools, booking channels (if available)*

	(please refer to section 4.1)	*monitoring system, e-ticketing system, infosystems, etc.)*	*To end-users (B2C) Business to Customer*	*To Operators / Authorities (B2B, B2A) Business to Business, Business to Administrative*

7. Main gaps and issues related to the transport services		
	Mobility Transport service *(please refer to section 4.1)*	**Main Gaps and issues** *Please list and describe the main gaps and issues related to the mobility/transport services operated in the Pilot*
7.1		

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8. Main objectives of the Pilot			
	Objective	**Short Description**	**Context**
8.1	1)		☐ free-standing ☐ part of a broader initiative beyond the scope of INCLUSION project
	2)		☐ free-standing ☐ part of a broader initiative beyond the scope of INCLUSION project
	3)		☐ free-standing ☐ part of a broader initiative beyond the scope of INCLUSION project
8.2	*If relevant, please describe the framework in which the Pilot activities are involved in (max. 100 words)* *e.g. Government policy that is switching from a supply-oriented view on public transport to a more demand oriented system, Potential agreements between cities/regions, Changing in transport regulation schemes, development of the SUMP…*		

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PART B: Identification of possible solutions to be demonstrated in the Pilot Labs

9. Preliminary analysis of possible ideas to be implemented		
9.1	Main changes involved in each Pilot Lab concept (to address objectives detailed in section 7)	☐ Service ☐ Target groups ☐ Processes ☐ Systems ☐ Tariff ☐ Funding/Business models ☐ … *Please detail below once chosen the topic*:
9.2	Possible solutions to be implemented (max. 100 words) *(to fill if there are some solutions that have been already identified)*	*Please list and describe the possible solutions to be implemented*
10. Possible features relevant to the Pilot Labs		
10.1	*(to fill if there are some solutions that have been already identified. More than one can be chosen)* ☐ Addition or extension of services in terms of lines or coverage area; ☐ Extension of the operational hours/days of existing service; ☐ Targeting specific user groups, population groups, market segments, etc.; ☐ Opening a restricted service to other groups or to the general public; ☐ Coordination of services among multiple service providers or funding agencies; ☐ Integration of services with general public transport; ☐ New or enhanced payment methods; ☐ New or enhanced passenger information services;	

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	☐ Addition of customer-facing ITS/ICT; ☐ Addition of back-office ITS/ICT; ☐ New or enhanced operations management; ☐ New or enhanced customer handling and support; ☐ Marketing and outreach; ☐ Interfacing with destinations (e.g. hospitals, leisure locations) for bookings or dispatch; ☐ Adjustments to the administrative or financial processes; ☐ …

11. Preliminary analysis of some potential barrier to overcome, risk and constraints to be managed and opportunity to be exploited		
11.1	*Please describe the potential barrier/risks/constraints that have already been identified max. 100 words*	
11.2	Preliminary identification of items of uncertainty or with long lead-times for the changes and solutions considered *(More than one can be chosen)*	☐ Conditionality/dependency on some other activity, project, event, etc. being started or completed ☐ Requirements for negotiations with others stakeholders, including communities ☐ Changes in work practices which would require negotiation and reaching acceptance by labour force or contractors ☐ Approvals for a pilot project, new service types, new funding commitments, etc. which will require some preparatory effort ☐ Requirement for a new/amended regulation, order, etc. that must be yet prepared and approved by law-makers/decision takers ☐ Potential opposition from stakeholders, including existing or target users, that could cause delay or even blocking of the proposed pilot ☐ …

12. Local stakeholders and partnership likely to become involved during the Pilot implementation in INCLUSION		
12.1	**Title - Name**	**Typology**

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		(e.g. Transport/Mobility Operators, Local Authorities, Service Contracting Authority, Citizen associations…)
13. Expected improvement		
13.1	"Customer-facing level" – B2C services (max. 100 words)	
13.2	"Back-office level" – B2B/B2A services (max. 100 words)	